MODEL AIRPLANE NEWS

21 WAYS TO MOUNT SERVOS

48120

THE WORLD'S PREMIER R/C MODELING MAGAZINE

September 1994

TOP GUN
PECTACULAR
HOT
HOTO ISSUE

Flight Test: VERTIGO VTOL

T-Tail Elevator Linkage Secrets

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SEPTEMBER 1994 VOLUME 122, NUMBER 9

MODEL AIRPLANE NEWS

ABOVE: Kerry Sterner (center left) holds his Beechcraft Starship during static judging at Top Gun '94. Photo by Tom Atwood.

ON THE COVER: Top Gun images—top right: Bob Violett's twin-engine F-4 prototype; middle: Terry Nitsch's BVM F-86F Sabre (1st place); bottom right: second-place winner Garland Hamilton (left) demonstrates landing gear of his ⅙-scale, BVM F-80; bottom center: Charlie Nelson's scratch-built WACO VKS-7F (9th-place winner). Photos by Walter Sidas.

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EDITORIAL

TOM ATWOOD

SLOW-FLIGHT CONTEST RULES SUMMARY

The following summarizes the slow-flight design contest rules. The summary includes information previously published in our February, March and May issues, with some minor additional clarifications.

1. Sponsors and prizes. The contest is sponsored by *Model Airplane News*, the NASA Langley Research Center, the NACA/NASA Alumni Association and Shapery Gyronautics Corp. Prize money totalling $6,250, provided by *Model Airplane News* and Shapery exclusively, will be paid to winners in three categories: Internal Combustion, Class A—"Floaters": 1st prize—$1,000; 2nd prize—$500; 3rd prize—$250; Internal Combustion, Class B—"Conventional Aircraft": 1st prize—$1,500; 2nd prize—$825; 3rd prize—$425; Indoor Electric, Class C: 1st prize—$1,000; 2nd prize—$500; 3rd prize—$250. Winners will also receive certificates signed by aviation luminaries.

2. Purpose. The purpose of the contest is to spur development of practical low-speed flight capability, i.e., to expand the performance envelope of traditional designs and to foster a competition that will generate new slow-flight designs and add to existing knowledge.

3. Contest window. The contest began January 1, 1994. Entries must be received by December 31, 1994. Entries will be evaluated by a committee comprising NACA alumni and NASA design engineers. Winners will be chosen based on performance and innovative design. Awards will be presented in early 1995 at the Virginia Air and Space Center in Hampton, VA.

4. How to enter. Submit entries to Julie Soriano, Managing Editor, *Model Airplane News*, 251 Danbury Rd., Wilton, CT 06897. Please write "Slow-Flight Design Contest" on the outside of your package. If you have specific questions relating to the contest, contact Tom Atwood at (203) 834-2900; fax (203) 762-9803; Internet address: toma@airage.com. Submit the following: a three-view, aircraft specifications, aircraft performance (slow-speed run and, if applicable, flight-envelope performance), description of the design (not to exceed two single-spaced, typed pages), still photos of the aircraft, a letter signed by a CD and local club president (or suitable substitute) and a videotape of flight tests. Winners must be prepared to submit a construction article (to include a rendering of full-size plans from which we can create an inked Mylar), black-and-white construction photos, and color slides of the model on the ground and airborne (we can offer direction to simplify this task).

5. Requirements and prohibitions. Team entries are allowed. All internal-combustion entrants must have a total combined displacement of between .40 and .50ci. The number of engines is optional, e.g., one could use three .15s or a single .45, or some other combination. If the engine displacement requirement has been met, auxiliary electric motors may be used. At least one prop must be able to function in a horizontal axis at least some of the time. Tilt wing, "flying pancake" and vertical takeoff planes that rotate in the air meet this requirement. No lighter-than-air gas is allowed. Previously published designs are excluded.

Helicopters are excluded, as are purely conventional aircraft that the entrant merely hangs on its prop. The same aircraft must be used for both low- and high-speed runs. It is not required that the aircraft have low- and high-speed modes but, if it does, it must be able to reconfigure from low- to high-speed modes purely by radio control (wings cannot be physically replaced by the pilot). Control of the aircraft in slow-speed flight will be qualitatively assessed by the NASA and NACA/NASA alumni panel based on videotapes submitted. (Do your best when documenting your flights; we hope the broadcast media will pick up a video of winning designs!)

Wing loading will be determined by dividing the weight (in ounces) by the wing area (in square feet) when the wing is in its minimum area mode. "Minimum area mode" means that any flaps, slats, telescoping sections, etc., are all retracted for high-speed flight. The disk area of any fixed fans, rotors or props that exhaust vertically downward will be counted as wing area whether or not they're in operation. The total area of such fans cannot exceed 60 percent of the wing (or lifting body, or wing plus lifting body) area when in the minimum area mode. Minimum wing loading (20 ounces per square foot) for the heavier wing-loaded internal combustion class should be calculated based on the minimum area mode. Also note that fans or rotors that are capable of pushing or pulling in both vertical and horizontal axes are not included in the wing-loading calculation. Thus rotating nacelles, rotors on tilt wings, or rotors on craft such as Zimmer's Skimmer, all of which can motivate the aircraft in both vertical and horizontal axes, are not part of the wing-loading calculation.

No other design constraints exist: large high-lift devices, thrust vectoring tabs, "channel" wings, auxiliary fans, telescoping wings, tilt wings and powered glider/autogyro hybrids are all interesting possibilities. Contestants may not trade vertical speed for apparent slow forward flight, i.e., may not descend at a steep angle along the course, nor may "bobbing and weaving" be used to maximize the time elapsed in flying the course. Planes must fly at a height of at least one wingspan. Reversing direction in the course of a pass to prolong the time spent in making that pass is disallowed. In all cases, a plane must be flightworthy after completing its record test run. Sponsors are allowed.

6. Description of contest classes.

• Internal Combustion, Class A—"Floaters."

(Continued on page 92)

GAUNTLET '94

East Coast heli fans, take note: in Sparta, NJ, on August 20 and 21, Miniature Aircraft USA will sponsor two days of intense competition among the world's top helicopter pilots. Three rounds each of FAI, the dreaded "Unknowns" and a separate freestyle event will be flown for a total cash purse of $1,700. Admission is free. For information, contact John D'Arcangelo at (908) 687-4567.

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AIRWAVES

WRITE TO US! We welcome your comments and suggestions. Letters should be addressed to "Airwaves," **Model Airplane News,** 251 Danbury Road, Wilton, CT 06897. Letters may be edited for clarity and brevity. We regret that, owing to the tremendous numbers of letters we receive, we cannot respond to every one.

ERRATA

In the '94 *Model Airplane News Buyers' Guide*, we published an incorrect telephone number and P.O. Box number for R&R Distributors Inc. Their telephone number is (800) 752-1650; their P.O. Box number is 144. We apologize for any inconvenience.

ASKIN' FOR AN AGWAGON

I need help! I'm trying to scratch-build a Cessna Agwagon, and I'd appreciate any help you can give me. Do you know of any sources for three-views and documentation? This is my first scratch project. Thanks for your time and effort.

EDWARD CSANADY
Brighton, MI

Ed, there are a couple of sources of plans and three-views for the Cessna 188 Agwagon. Bob Banka's Scale Model Research, 3114 Yukon Ave., Costa Mesa, CA 92626, (714) 979-8058, offers three photo/documentation packages for the Agwagon with information and color prints. Scale Plans and Photo Service, 3209 Madison Ave., Greensboro, NC 27403, (910) 292-5239, offers four similar packages. For model construction plans, New Zealand Aero Products, 34 Ward Parade, Stirling Point, Bluff, New Zealand, (03) 2128192, sells a plans and parts package for a 1/4-scale, 123 1/4-inch wingspan Agwagon B (shown in photo; details also included for the Aghusky, Agtruck and Agpickup). The plans ($38 U.S.) include four large sheets, three-views and documentation. The company also offers many fiberglass parts for the model, including an engine cowl, a canopy frame, a tail cone and wingtips. A hardware package and wooden parts are also available. If any readers are aware of other sources of Agwagon plans, please let us know; we'll pass along the info. GY

EYE OPENER

I was pleased to read your editorial in the June '94 issue of *Model Airplane News* on the subject of eye safety. I've been an optician for 17 years and am now studying to become an optometrist. Until recently, the issue of eye safety has been underreported. It's a relief to see a publication of your stature giving eye safety the column space it deserves. I am, however, sorry that a potentially tragic accident was the subject, but I'm glad that Mr. Phipps suffered no injuries. We do, however, need to read more about sight saved by using high-quality sun/safety glasses, and less about sight lost through carelessness or fate. I find this an opportunity to write a little on the subject of sunglasses, safety and the various products available.

The first thing to look for in sunglasses is a high degree of protection from ultraviolet radiation. UV light has been shown to contribute to the formation of cataracts (a clouding of the lens inside the eye), and it causes eye fatigue. Contrary to what we've been led to believe, advertisers' claims about UV protection aren't always accurate. There are no government standards that control the market for nonprescription sunglasses. Unscrupulous manufacturers can say anything they want about their sunglasses. Without a spectro scopic analysis, there is no sure way to tell if a certain lens is blocking the UV light. Many manufacturers do go to great lengths to test their lenses, and they advertise the results. Go with brand names you know, or ask a licensed or certified optician.

Impact-resistance is also important. Protecting your eyes from impact is important at the field as well as in the shop. Polycarbonate is a perfect material for sunglasses. It offers protection from impact and from UV-A

rays. It has been used in bulletproof windows and R/C cars. Even when it's clear, this material will block 98 percent of all UV-A rays and 94 percent of UV-B rays. With lab work and tinting, this can be increased to 100 percent for both.

Owing to the difficulty in processing, polycarbonate has had a dubious reputation among opticians. In the past, it has been almost impossible to make a polycarbonate lens without some degree of aberration, or waviness. I'm pleased to report that this is no longer true. New manufacturing techniques have improved the optical quality of this lens so that it approaches the quality of the finest optical glass. (Even hardened, glass is still too brittle to be safe.) There are "cheap" polycarbonate sunglasses on the market. These are most often made using old technology. These lenses have imperceptible waves that will strain your eyes over time. Headaches and fatigue will result. You get what you pay for.

Although not essential, another plus in sunglasses is infrared protection. IR rays are heat rays. Those who spend afternoons looking skyward can appreciate the heat that comes from the sun.

The best news for prescription-eyeglass wearers is that all of these qualities are available in prescription sunglasses. I recommend a Gentex polycarbonate with a blue-frost coating. It satisfies all the above criteria, and it can be put into the frame of your choice. Specify a 3.0mm safety thickness as prescribed by the American National Standards Institute Report, Z-87.1, 1993 revision.

Few things, other than unplanned ground contact, can spoil a day at the field like a bad headache. Plan your purchase. Don't buy off-the-rack shades based on the claims made on the tag. Consider them as carefully as you would your choice of a transmitter or an engine. A quality pair of sunglasses is an essential part of your flight-line equipment, both for safety and for comfort.

DAVID KINCADE
Jefferson City, MO

■

AIR SCOOP

CHRIS CHIANELLI

New products or people behind the scenes; my sources have been put on alert to get the scoop! In this column, you'll find new things that will, at times, cause consternation, and telepathic insults will probably be launched in my general direction! But who cares? It's you, the reader, who matters most! I spy for those who fly!

LESS IS MORE

Not only is Hitec's new HS-205 (HS-205 MG metal-gear version) mini-servo 20 percent smaller and 30 percent lighter than their standard sport servo, but it also has more torque (44oz.-in.) At 4.8 volts, transit time is .20 second measured through a 60-degree sweep. The versatile HS-205 sounds perfect for when the job is big and the space is small. Dimensions length—1.3 inches; width—0.6 inch; height—1.3 inches. Contact: Hitec RCD Inc., 10729 Wheatlands Ave., Ste. C, Santee, CA 92071; (619) 258-4940; fax (619) 449-1002.

Rutan ARES

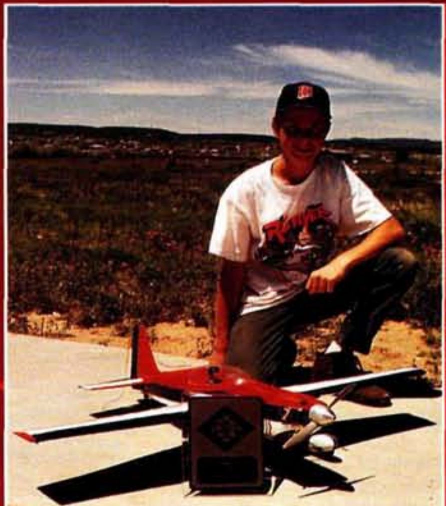
Here's a look at Kerry Sterner's latest creation—an exact ⅕-scale Rutan ARES. Kerry tells me the ARES has been designed in ⅕-scale for two reasons: it yields a generous amount of room for a large fuel supply right on the CG; and at ⅕ scale, the model has an 84-inch wingspan, making it IMAA mono-wing legal. Specs: wing area—1,100 square inches; empty weight 14.5 pounds. It features fiberglass fuselage, booms and fins; and balsa-sheeted, foam-core wings and canard. It was designed for an O.S. .91 with a Ramtec fan and a Violett remote mixture and pipe. The ARES prototype is currently flying and will be available in semi-kit form for ducted-fan or turbine power some time this year (after the turbine installation has been flight-tested). Contact Kerry J. Sterner, 661 Moorestown Dr., Bath, PA 18014.

Chopper Glow

These new, brightly colored, translucent G-Blades from Hobby Hangar are now available for ZX, SR and ZR .30-size machines. Molded of epoxy-resin, they are pre-balanced and CG-corrected. Because they're hollow, these main rotor blades may be filled at the tips (1ml each tip) with glow-in-the-dark cyalume fluid to provide a full-disk image for those night missions. For more info, contact Hobby Hangar, 153 Lloyd Ave., Florence, KY 41042; (606) 283-5746; fax (606) 282-4666.

Natural Ability

Flying against older, more experienced pilots who flew airplanes costing many times that of his little Extra 3.25, 14-year-old Eagle Scout Andrew Bowker walked away with first place in Freestyle at the recent IMAC Cactus Classic held at Mesa, AZ, this past June. Built from *Model Airplane News* plans, the Rich Uravitch-designed Extra 3.25 weighs 3.75 pounds and is powered by an O.S. .32 spinning an APC 10x5 prop. Trained by his dad, Brian, a veterinarian, on a *Model Airplane News* Tutor, Andrew now enjoys teaching his best friend to fly and fun flying with his brothers Chris and Kurt. In recent years, Andrew and his 3.25 have consistently placed among the top three in the IMAC Sportsman Class. Drop him a note of congratulations at Box 1929, Edgewood, NM 87015.



VERY SOLID!

Bob Davis, the president of Davis Model Products and the recipient of the AMA's prestigious Technical Award, introduces three new engine mounts that are machined out of solid 6061 T6 aluminum-alloy bar stock. These precision units are stronger and lighter than their cast-aluminum counterparts. Since the top and bottom surfaces of the arms are machined parallel to each other, no thread-tapping is required. Simply drill four holes, insert four bolts and secure them with aircraft locknuts, and you're finished! The MM 60 regular (short) is for .60 to .90 2-strokes, the MM 60 L (long) is for .60 to .90 4-strokes and the MM 1.20 is for O.S., Saito and YS 1.20 4-strokes and large 2-strokes like the O.S. 1.08 and Webra 1.20. For more info, call (203) 877-1670, or write to Davis Model Products, P.O. Box 141 Milford, CT 06460.

TWINBEE

Here's a sneak look at G&P Sales' new Twinbee. Like all G&P kits, the new 71-inch-wingspan Twinbee kit includes: a high-quality fiberglass fuselage; low-density, small bead, foam-core wing and stab; all necessary wood; vacuum-formed parts; extensive hardware pack; 30-page instruction booklet; and full-size plans. Contact G&P Sales, 410 College Ave., Angwin, CA 94508; (707) 965-1216.

FLY ON INSTRUMENTS!

Hobby Lobby's new B.T.A. autopilot simply plugs into your receiver, elevator servo and aileron servo (or rudder servo, if your plane doesn't have ailerons). The unit is then switched on and off by means of an auxiliary channel. According to Hobby Lobby, your plane will fly like it's on rails, no matter how gusty the wind conditions are or how erratically the sticks are moved. After initial adjustments (simply made with a small screwdrver), a novice can smooth out his takeoffs and landings and, if he gets into trouble with the unit switched off, switching it on will quickly level the model out if the elevator and aileron sticks are at neutral. The unit is basically a gyro and an aneroid rate-of-climb device, sensing barometric pressure changes during climb and feeding information to the built-in microcomputer. The B.T.A. is made in Israel by a firm specializing in RPV control systems. It's warranted and serviced by their USA rep, Hobby Lobby Intl., 5614 Franklin Pike Cir., Brentwood TN 37027; (615) 373-1444; fax (615) 377-6948.

AQUA-BEE

Have you ever been lakeside camping and imagined how great it would be if you had a great flying, portable floatplane there with you? Well, now Clancy Aviation has a float kit for their unique little Lazy Bee (featured in this issue). According to Clancy, the straightforward assembly of the foam and sheet-balsa floats takes just a few hours and weighs only 2 ounces more than the standard landing gear. Switching from float to wheel, or vice versa, takes under five minutes. Just think of it: a country lake, a Lazy Bee on floats and an O.S. Surpass .26 4-stroke engine. Now there's a recipe for some quiet R&R.

"Beam down the SOLAREZ, Scotty."

Solarez is a combination of high-strength polyester resin, chop-strand fiberglass and a unique, ultraviolet-activated catalyst all in one tube. The mixture quickly hardens (45 seconds) but *only* when exposed to sunlight or a UV light. With equal light, Solarez cures as fast in sub-zero temperatures as it does in scorching heat. This reaction will also take place in thick cloud cover. When used in the shade or indoors, there is no time restraint for lay-up. The product will not cure without UV rays. "Fascinating..." "Shut up, you pointy-eared idiot! I'm a doctor—not a modeler." Contact Wahoo Intl., 2605 Oceanside Blvd., Oceanside, CA 92054-4585; communicator no. (619) 967-7873.

HOW TO

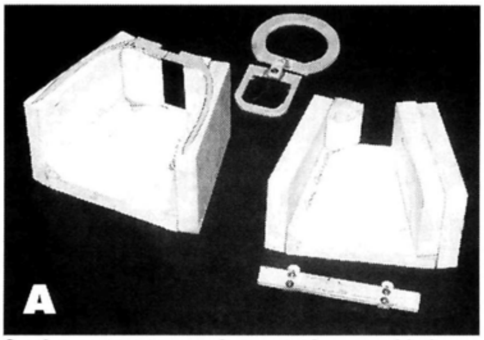
Ducted-Cowl Design

LOW DRAG AND COOL

PART 2

by ANDY LENNON

OVER THE YEARS, I have designed and built many types of cowl. They ranged from laboriously hollowed out solid balsa to fiberglass-and-epoxy lay-ups on dissolvable foam mandrels. The ducted-cowl construction described in the first installment of this two-part series (see Figure 1 and photos) has been used on at least seven model designs. The sound-deadening properties of thick balsa sheet are a definite advantage. In this article, I will give more details on ducted-cowl construction and also touch on design considerations for a cowl mounted in a pusher configuration.



Cowl components are shown partly assembled.

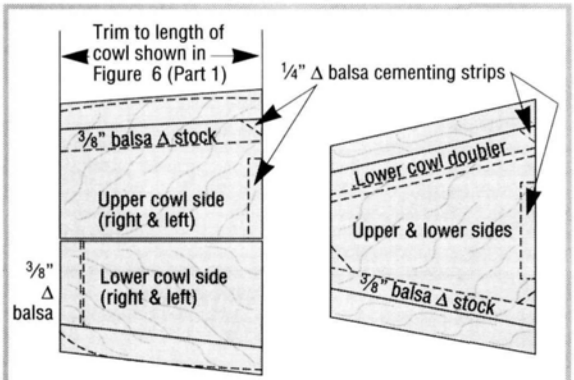


FIGURE 1
Cowl box detail; 1/2-inch balsa sheet; internal muffler.

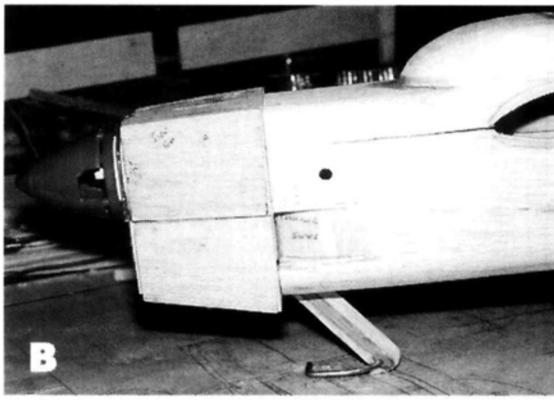
CONSTRUCTION HINTS

That portion of the cowl behind the spinner and surrounding the engine crankcase is solidly CA'd to the engine bulkhead. The other, removable, portion surrounds the cylinder. The level of the parting line between these two parts is important. It must be horizontal, and it must separate through the center of the needle-valve needle—either just above or just below it. Obviously, a suitable slot or slots (half above and half below the parting line) is essential to clear the needle. If an external muffler is used, then suitable cutout(s) must be made to clear the portion that connects the engine exhaust to the muffler. In Figure 2, note the 1/32-inch plywood parting-line separator that guides the shaping of the cowl both inside and outside. It is firmly cemented to the removable portion of the cowl.

ASSEMBLY AND SHAPING

Photo A shows balsa sheet, tri-stock and plywood components partially assembled into the cowl's two parts. Carefully trim the length of both parts of the cowl's balsa to suit the length of your installation, as shown in Figure 6 (Part 1), "Cowl side view—tractor engine; internal muffler."

At this stage, the fuselage should be finished (but not covered). Temporarily install the engine (less the needle-valve needle) and muffler on the engine mount so that the cowl can be shaped inside as shown in the photos and drawings. The



The cowl "box" has been clamped into position for external shaping.

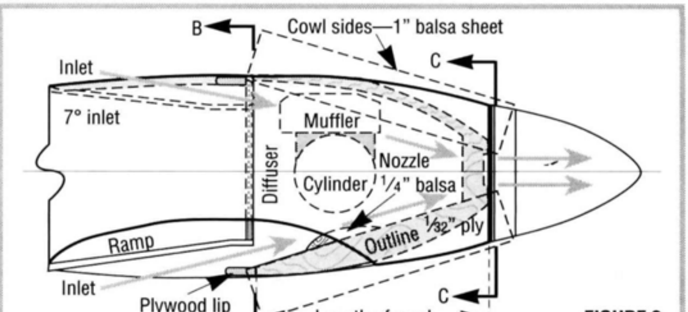


FIGURE 2
Top view of pusher engine cowl.

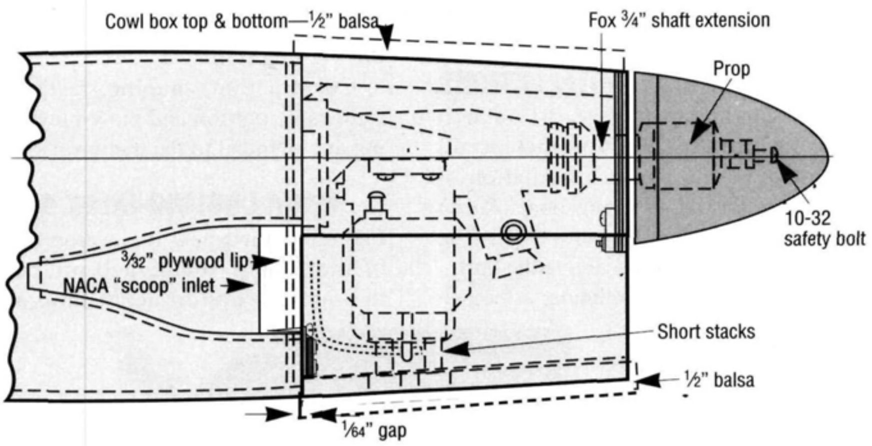


FIGURE 3
Side view of pusher engine cowl.

ply parting-line separator guides this effort. A Dremel sanding drum and drill will do this quickly and easily.

The cowl structure around the crankcase requires only minor internal contouring to clear the muffler; the removable portion needs considerably more internal shaping to clear the cylinder and muffler.

The three flat hold-downs are both CA'd and bolted (2-56 bolts and nuts) to their plywood parts. (Note the bolt-orientation nuts inside.) File the round bolt heads level with the bottom of the screwdriver slot after they've been installed in the plywood.

Install and lightly tack-glue the cowl "box" to the engine bulkhead as shown in photo B, with the spinner ring cooling-air entry assembly cemented to both portions of the cowl.

Using an old spinner backplate of the correct size, clamp the box into position by installing the prop nut and washer, putting a 3/32-inch balsa sheet spacer between the spinner backplate and the ply spinner ring.

Shape and sand the outside surfaces to match the spinner; the cooling-air entry plywood parting line; the 1/32-inch ply separator and the fuselage contour, as shown in photo C.

Next, remove the cowl and take the engine and muffler off the motor mount. Epoxy the rear Carl Goldberg Models* flat hold-down (FHD) ply assembly in the removable portion of the cowl as shown in photo D and Figure 4. This requires some trimming of both the ply and the balsa. Note that the open side of all three FHD's "hooks" should face away from the muffler side.

Now clamp the cowl into position as you did before, carefully aligning it with the spinner and fuselage. Through the air-entry hole, using the rear flat hold-downs as guides, mark the positions of the no. 2 shoulder screws on the engine bulkhead. Remove the cowl, drill 1/16-inch holes in the bulkhead, put some CA in the holes, and install the two screws.

Permanently reinstall the engine and muffler, connect the carb-to-engine-servo linkage, replace the needle-valve needle, install the fuel and muffler pressure tubing from the engine to the fuel tank, and connect the glow-plug clip to the glow plug.

Solidly CA the fixed portion to the engine bulkhead, and clamp the whole cowl into position as before, and as shown in photo C. In photo D, both parts are ready for painting. The engine's accessibility is evident.

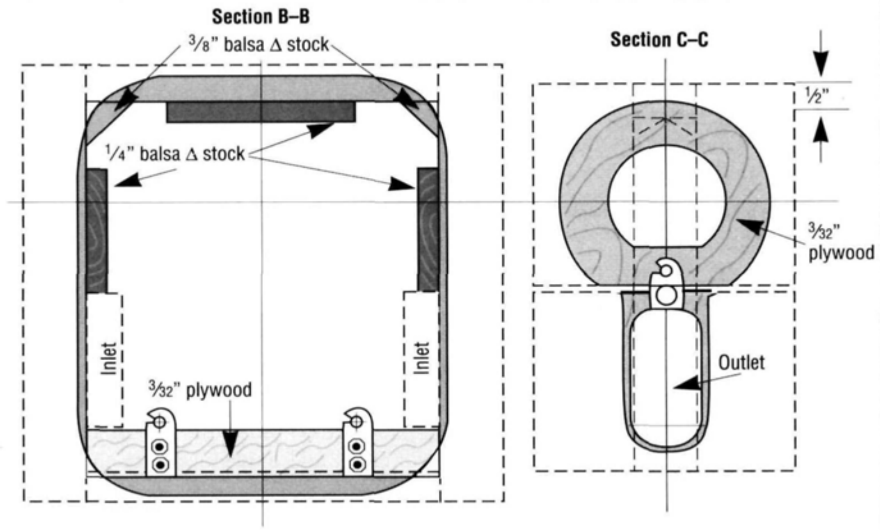
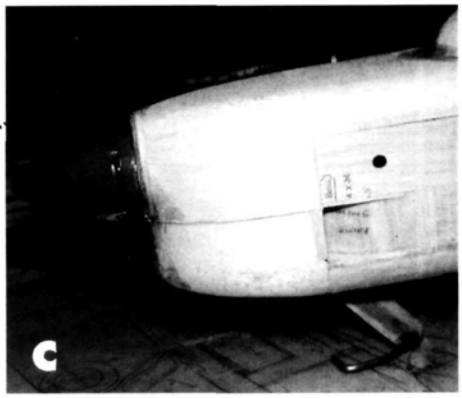


FIGURE 4
Pusher engine cowl sections and hold-down detail.

GLOW-PLUG ENERGIZING

With the engine enclosed, the glow plug is energized by means of a two-conductor, closed-circuit type, Radio Shack phone jack (catalogue no. 274-248). To energize the plug, a mating, 1/8-inch, Radio Shack plug (catalogue no. 274-286) is wired to the external power source and inserted into the jack. This is a major safety feature because the jack may be located well away from that deadly, rotating prop for plug removal. Figure 6 (Part 1) details the bronze glow-plug clip that's easily disengaged from the glow plug when plug replacement is necessary.

The jack is mounted through a 7/32-inch-diameter hole in a small square of 1/16-inch plywood. Both are epoxied to the inside fuselage wall so that the jack's knurled nut projects through a 5/16-inch-diameter hole in that wall as in the first photo shown in Part 1 (page 100). Figures 5, 6 and 7 provide a wiring diagram and engine-servo detail for an "onboard" glow-plug energizing system that heats



The shaped and sanded cowl. The upper portion has been CA'd to the engine-mount bulkhead.

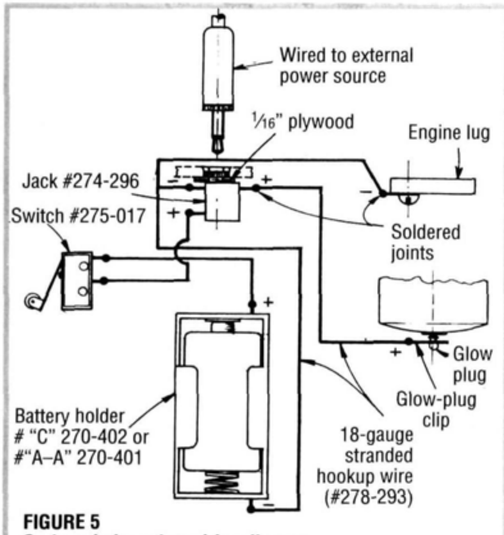


FIGURE 5
On-board glow-plug wiring diagram.

the plug in flight, but only at low rpm. The system ensures a reliable idle, particularly for 4-stroke engines. It is fully described in the January '88 issue of *Model Aviation* magazine.

ENGINE PRIMING

Priming a fully cowled engine is easy. Invert the model on your field box to bring

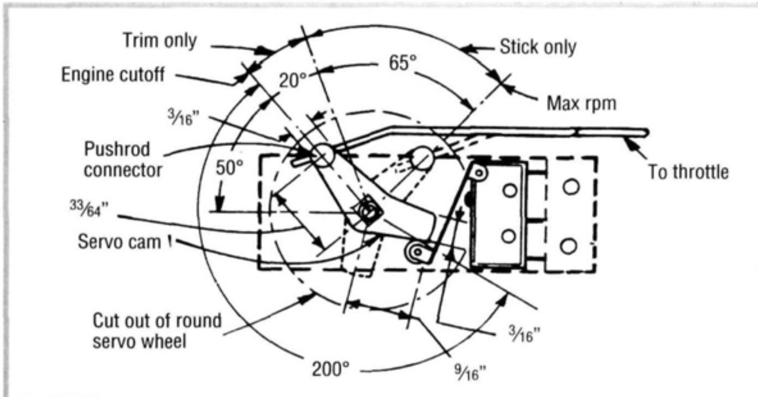


FIGURE 6
Engine servo lengthwise in fuselage.

the engine upright. With a squirt bottle, inject a few drops of fuel into the carburetor. If the carb is closed, the carb entry forms a small cup which, when filled, provides adequate priming. The cooling-air entry hole permits this method of priming without cowl removal.

If, after a flight, the engine is stopped by closing the carb, subsequent engine starts don't require priming. To avoid "hydraulic lock"—having fuel trapped between the piston and the cylinder

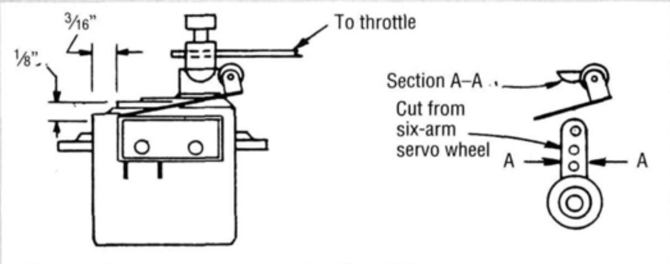


FIGURE 7 Small engine servo (Futaba S33-S133).

head—apply your electric starter with the model inverted (engine upright).

PUSHER ENGINE INSTALLATIONS

The photo in Part 1 (page 101, on left) and Figures 2, 3 and 4 in this installment show the pusher installation of the Seagull III—a flying boat (*Radio Control Modeler,* October '92). The engine sits in a nacelle above the hull.

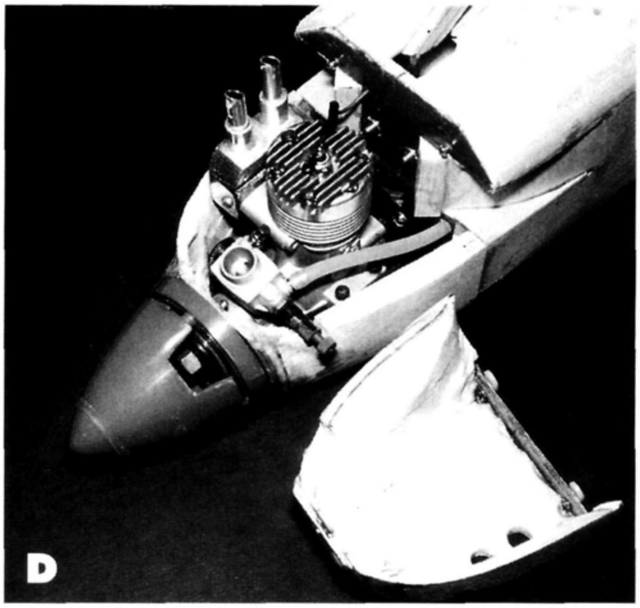
For improved streamlining, a 3/4-inch Fox* crankshaft extension was used, as shown in Figure 5. An enclosed muffler is mandatory, because the external muffler would exhaust the wrong way, facing forward, and it could not be reversed, because that would foul the prop and prevent the propeller from rotating.

Cooling air enters the cowl through two, NACA-developed, low-drag, submerged air intakes recessed into the nacelle (or fuselage) sides ahead of the engine bulkhead. The combined areas of these intakes is the cylinder area described in Figure 1 (Part 1) plus 40 percent. The exit slot under the spinner has the same total area as the entries. The rotating prop "sucks" cooling air out of this cooling slot.

Construction, shaping, fastening the removable portion and glow-plug energizing are identical to the tractor installation.

NACA COOLING-INLET DESIGN

Figure 8 shows how to develop the shape of the NACA submerged intake. Note the intake width-to-depth ratio and the ramp floor at 7 degrees to the outside surface.



This cowl detail shows that servicing the engine is easy.

Table of ordinates

X/L	Y/(W/Z)
0	0
0.1	0.004
0.2	0.084
0.3	0.234
0.4	0.386
0.5	0.534
0.6	0.612
0.7	0.688
0.8	0.764
0.9	0.842
1.0	0.917

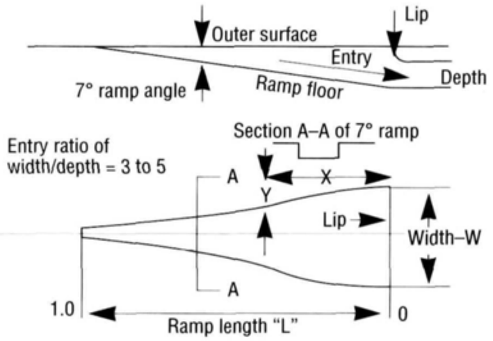


FIGURE 8
Details and ordinates of NACA submerged intake.

Over the years, I've used pusher engines cowled as described on five models. Cooling problems have not occurred.

In both Part 1 and Part 2, illustrations and photos show inverted engines (author's addiction). For upright installations, simply turn the photos and drawings upside-down! Good luck!

**Addresses are listed alphabetically in the Index of Manufacturers on page 137.* ■

PILOT PROJECTS

RV3 FOR ME!

That's what Tony Sokol of East Dundee, IL, says about his first giant-scale, fiberglass-fuselage model. Built from a D&R Aircraft kit, the RV3 has an 85-inch wingspan and weighs 21 pounds. Power comes from a Saito 270 that's equipped with an onboard glow lighting system. The fuselage had a few pinholes in it, but after a couple of nights with some glazing putty and sandpaper, the model was ready for a Rustoleum paint job. The foam wings come sheeted, and the ailerons are ready to hinge; the wings look great with a MonoKote finish. The model has six servos with dual-elevator and dual-aileron servo setups. A pull/pull rudder setup with a ball-bearing servo completes the control system. Though it's a very simple design, Tony says that the model looks sharp.

BERKLEY INVADER

Joseph Manginelli of Bronx, NY, built this Douglas B-26 Invader from a Berkley kit and powered it with two Fox .40 engines. The 87½-inch-span bomber has working flaps and a wing area of 862 square inches, and it's controlled by an Expert 6-channel radio.

SUPER-SIZE SUKHOI

This 28-percent-scale Soviet Sukhoi SU 26MX was built by Donald Forte of Mashpee, MA, from an Ohio R/C Models kit. The giant aerobat is powered by an O.S. 300 flat twin engine turning a 20x10 Dynathrust prop. It's covered with Super MonoKote, and a Futaba 7UAPS radio with 9201 coreless servos keeps the model under control. Don must have a really big vehicle to transport this one to the flying field

GREAT GREAT LAKES

Scratch-built by Chuck Spencer of Mecosta, MI, this Great Lakes Special bipe is a rendition of the aircraft flown by Harold Kriers. The 38-pound model is powered by a 5-cylinder, 3.8hp Saito radial engine. It's covered with Hobby Lobby's Oracover, and all the landing and flying wires are functional. K&B Super Poxy paint is used on the engine cowl and wheel pants. Chuck says that he has been reading *Model Airplane News* for a long time and only missed three years of the publication during WW II. He has been flying for 61 of his 69 years.

MODELCAD TRIXTER BEAM

With only a photo and a small three-view drawing of Henry Wieler's Trixter Beam as guides, Owen Nelson of Tacoma, WA, designed and built this modern version of the Beam using his ModelCAD program. Here held aloft by his son Daniel, the 36-inch-long model has a wingspan of 50 inches and 450 square inches of area. The model features modern, lightweight radio equipment in place of the original escapement; a four-point, hidden, wing-mounting system; a fully cowled, side-mounted engine; and an internally mounted muffler system. The 52-ounce Beam is powered by an O.S. .25FP. Owen loves *Model Airplane News'* continuing coverage of old-time R/C and all the photos and three-views published in Pappy deBolt's "Golden Age of R/C" column.

MODEL AIRPLANE NEWS MAGAZINE
FIELD & BENCH REVIEW

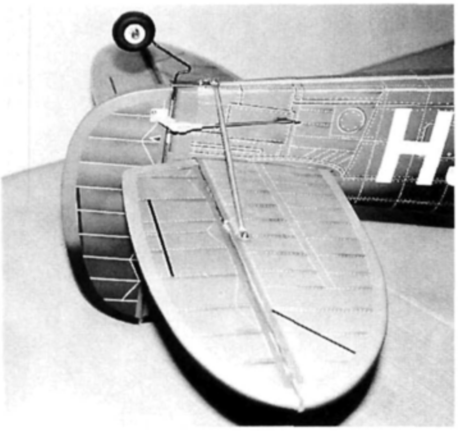
Spitfire

GREAT PLANES

Relive the Battle of Britain with this .40-size ARF

by JIM ONORATO

DURING THE FIRST 10 days of the Battle of Britain, Nazi Germany launched 25 major attacks against the Royal Air Force. British Supermarine Spitfires and Hawker Hurricanes engaged wave after wave of Messerschmitt 109s and 110s. The RAF lost 153 planes, but it shot down 697 of the enemy, owing, in large part, to the Spitfire's fitness for combat.



The tail section shows the placement of the stab bracing.

Now, more than 50 years later, Great Planes* has re-created the Spitfire—Britain's most famous WW II fighter—in a top-quality, semi-scale ARF. The Spitfire ARF is one of Great Planes' Legendary Warbird Series that includes versions of the A6M3 Zero, the FW-190, the P-40 Warhawk and the P-51 Mustang. This was my first experience with an ARF, so I was anxious to get started.

THE KIT

The word "kit" really doesn't apply to ARFs in general, and it certainly doesn't apply to the Spitfire .40. This plane is 90 percent complete and, except for the radio, engine, propeller, adhesive and fuel tubing, it includes everything you need. (You may also want to add a scale pilot figure as I did.) As usual, Great Planes has done an outstanding job of packaging its product. The illustrations and photos on the box are superb, and the main parts of the plane are wrapped in individual plastic bags.

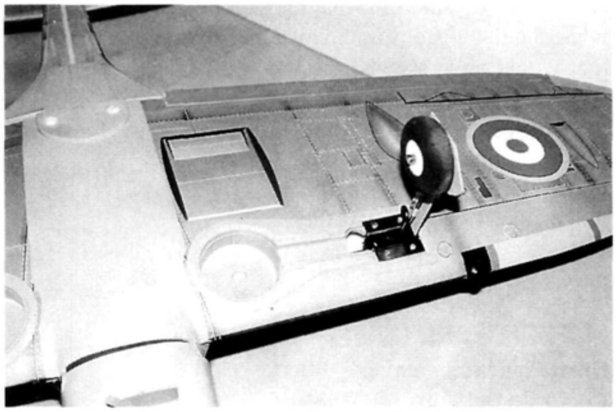
The Spitfire comes with rod-in-tube pushrods; an adjustable, glass-filled, nylon engine mount; a fuel tank; wheels; a spinner; decals; a multicolored, fuel-resistant outer coating; and high-quality hardware. The color scheme is olive drab, gray and shades of green camouflage with superimposed white panel lines and rivets. I thought that the white panel lines and rivets were a little bright and tended to overwhelm the camouflage. After the plane had been assembled and was flying, however, it looked great in the air. The hand-painted fairings and other plastic parts match the rest of the camouflage on the outer covering. A well-written, 28-page instruction booklet, chock full of photos and illustrations, guides the builder every step of the way without the need for full-size plans. The booklet even includes an appendix on flight trimming, which I found very useful. Nice touch!

ASSEMBLY

The Spitfire comes with fixed gear, but the instructions for retracts are also included. Before you begin the wing assembly, decide which gear you want because the initial steps are different for each. I decided to install retracts and bought a pair of Hobbico* low profile mechanical retracts (HCAP4010) and a Futaba* FP-S136G retract servo.

First, I glued two die-cut, lite-ply center ribs together; then I glued them and the forward and rear lite-ply wing joiners to the right wing panel. The two wing panels were then aligned and glued together with Pacer Technology's* 30-minute Z-Poxy.

Installing the retracts took a little more time than I had expected because I had to install the retract linkage in a wing that was already built. The Futaba servo has a very low profile, and it fit neatly into the wing. After cutting the struts to the proper length, I installed Du-Bro's* E-Z Adjust Axles (no. 614) and mounted the wheels to the retract struts.



Great Planes' Spitfire has inwardly retracting landing gear that widens its stance and improves ground handling.

There's a step missing from the retract instructions (after step 8 on page 11) about mounting the wing-bolt plates before the wing fairings are added. This step is covered, however, in the fixed-gear instructions (step 7, page 9). Also, the foam-rubber seal that's attached to the front of the wing fairing should be installed during

FLIGHT PERFORMANCE

• Takeoff and landing

Unlike the full-size Spitfire that has landing gear that are close to the wing root and retract toward the wingtip, the Spitfire's gear is farther out on the wing so the wheels can retract inward, toward the fuselage. This gives the main gear a much wider stance and significantly improves ground handling.

When I was ready to take off, I pointed the Spitfire down the runway, applied a little up-elevator to keep the tail down and advanced the throttle. The plane tracked beautifully with just a touch of right rudder. The tail lifted off the ground quickly, and when flying speed was attained, the Spitfire lifted smoothly into the air without rotating. Very realistic!

Landings are quite gentle. The Spitfire slows way down and has a shallow glide slope, and this allows the plane to descend very slowly. A slight flare just before touchdown results in a very smooth, three-point landing.

• High-speed performance

I hesitate to use the words "high speed" because the Spitfire is not a barnburner even at full throttle. With the landing gear retracted and the O.S. .70 Surpass wide open, however, the plane moves along quite nicely at a realistic, comfortable pace. It tracks well and is a smooth, stable flier at high speeds. I didn't encounter any high-speed tip-stalls, nor were there any surprises at top speed.

• Low-speed performance

The Spitfire is smooth and predictable at slow speed. It has a very low stall speed, and its stalls are gentle and straight ahead. The plane can be flown at a very slow speed without losing stability.

• Aerobatics

Although not designed for aerobatics, the Spitfire is capable of performing enough maneuvers to keep most Sunday fliers happy. Rolls are slow and realistic, but they require coordinated aileron and elevator control to keep them axial. The Spitfire performs large inside and outside loops without losing its heading, and it flies inverted with a moderate application of down-elevator. The plane will do a tailspin, but it has to be coaxed into it. I usually initiate a spin with a snap roll. Overall, the Great Planes Spitfire .40 ARF is a nice flying airplane.

step 12 on page 12. This step is also missing from the retract section.

I covered the top and bottom of the wing's center joint with the plastic wing fairings. Installing the wing dowels, molded wheel-well cups, gear covers, aileron servo and linkage completed the wing.

FUSELAGE AND TAIL GROUP

There wasn't much to do to the fuselage as it was essentially complete. After attaching two blind nuts to the wing-mounting plate, I epoxied the plate into the fuselage and aligned and attached the wing. I did run into a problem here. The wing-mounting plate interfered with the aileron torque rods and prevented the ailerons from moving. I remedied this by cutting away the section of the mounting plate between the blind nuts. You could also bend the upright arms of the torque rods forward, but this might be more difficult.

The die-cut stabilizer platform was epoxied into place, and the stab and the vertical fin were attached using 30-minute Z-Poxy. The tail wheel and the stab braces were attached next. I didn't locate the stab braces using the dimensions in the manual because that would have skewed the braces too far forward. Instead, I positioned the braces $\frac{7}{16}$ inch from the stab's trailing edge, and this made them parallel to the hinge line. I believe that the $\frac{15}{16}$-inch dimension given on page 18 is incorrect.

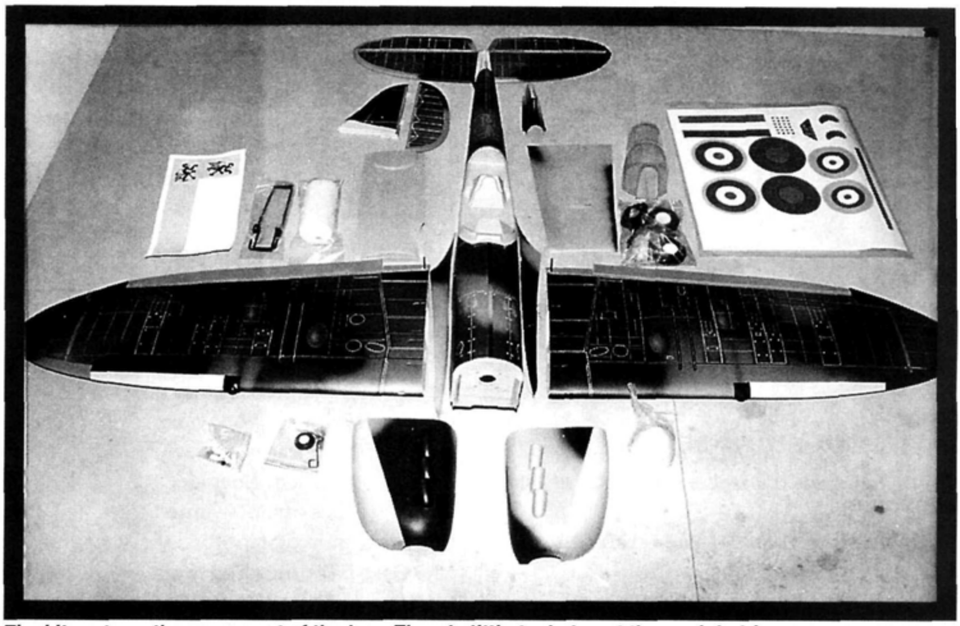
SPECIFICATIONS

Model name: Spitfire
Manufacturer: Great Planes Model Mfg.
Type: almost-ready-to-fly sport aircraft
Wingspan: 54 in.
Wing area: 550 sq. in.
Airfoil: symmetrical
Weight: 6 lbs., 8 oz.
Wing loading: 27.2 oz./sq.ft.
Length: 45.25 in.
No. of channels req'd: 4 to 5 (rudder, elevator, throttle, ailerons, retracts—optional)
Engine range: .40 to .46 2-stroke, .60 to .80 4-stroke
Engine used: O.S. FS-70 Surpass
List price: $299.99

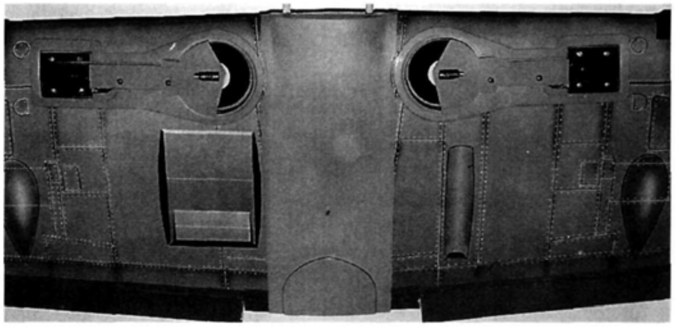
Features: the Spitfire .40 is 90 percent built and already covered with a durable, lightweight, layered composite. It has a large, engine-concealing cowl, hand-painted parts, and wheel wells and mounting rails are installed for optional retracts.

Hits
- Realistic flight performance and low-speed stability.
- Easy-to-follow instructions.
- High-quality Great Planes hardware included.
- Good-looking, semi-scale appearance.

Misses
- Interference between aileron torque rods and wing-bolt plate.
- Minor errors in manual (see text).
- Non-scale shape of spinner.



The kit parts as they come out of the box. There's little to do to get the model airborne.

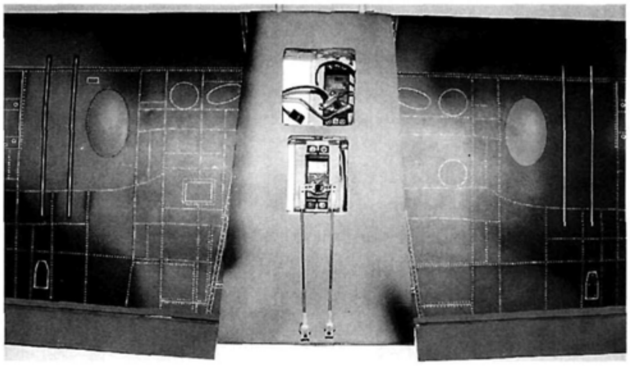


With the landing gear retracted, you can see how the covers clean up the wing by covering the wheel wells.

ENGINE AND COWL

Great Planes recommends .40 to .46 2-stroke or .60 to .80 4-stroke engines for the Spitfire. I used an FS-70 Surpass, which I mounted in the inverted position using the adjustable engine mount provided. I had to remove the choke assembly so that the thrust washer on the engine could be located 5 inches from the firewall as specified in the instructions. With the engine in the inverted position, I only had to cut small openings in the lower portion of the cowl for the valve covers and the muffler. This left the rest of the cowl intact. To cool the engine, I cut a semicircular vent in the underside of the cowl just in front of the firewall.

Some minor modifications were required to mount the cowl. The cowl is larger in cross section at the firewall than it is where it contacts the fuselage. To prevent the mounting screws from crushing the cowl, I placed $\frac{1}{4}$-inch spacers between the cowl and the mounting blocks and used longer screws. The spacers had to be glued inside the cowl; if they were glued to the mounting blocks, the cowl couldn't slide past them.



The retract and aileron servos sit in the wing's center section. It's a simple installation.

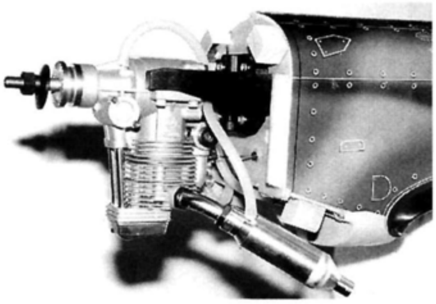
The spinner supplied with my kit was different from the one shown in the instruction manual. It was pointed and

If you want to get into the air quickly with something that looks like a real airplane and flies great, then the Great Planes Spitfire .40 ARF is for you.

not very scale-like. A more rounded spinner would improve the scale appearance of the Spitfire.

RADIO INSTALLATION AND BALANCE

Because I was using an O.S. .70 4-stroke engine, I positioned the servos toward the rear of the wing-saddle opening using the large servo tray as called for in the instructions. I placed several short lengths of inner pushrod material spaced evenly over the wire pushrods and inserted them in the outer casings, which had already been installed. I used a Z-bend to connect the elevator pushrod to the servo and a Du-Bro Kwik-Grip E-Z Connector (no. 608) to connect the rudder pushrod to its servo.



The O.S. FS-70 Surpass engine supplied plenty of power for the Spitfire.

The E-Z Connector is hexagonal, which makes it easy to hold while the setscrew is tightened. I placed the receiver just in front of the servo tray and the receiver battery directly behind the firewall. With this configuration, the Spitfire balanced right where it was supposed to with the CG 4½ inches behind the wing's leading edge.

Using the handy throw gauges included in the instruction booklet, I set the control-surface throws according to the instructions. Another nice touch! Installation of the wing fillets and the vacuum-formed canopy completed the assembly. Application of the press-on decals added the finishing touch.

CONCLUSION

The Spitfire is a well-made ARF that goes together easily and looks quite good when completed. If you want to get into the air quickly with something that looks like a real airplane and flies great, then the Great Planes Spitfire .40 ARF is for you.

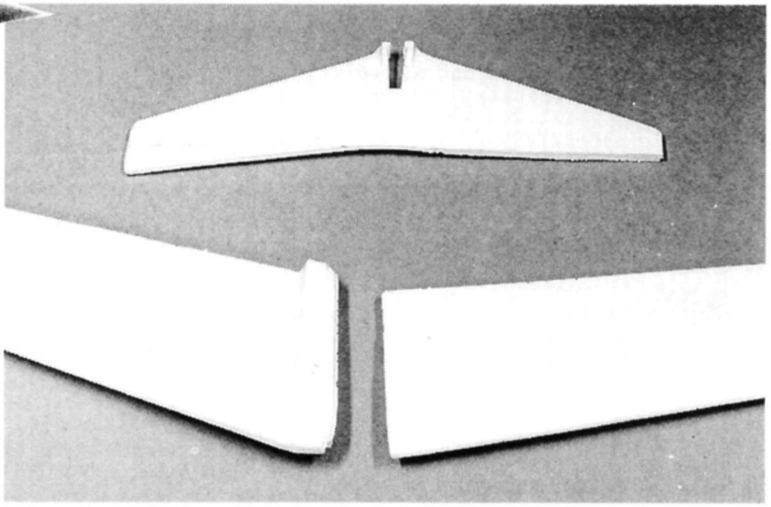
**Addresses are listed alphabetically in the Index of Manufacturers on page 137.* ■

An easy R/C conversion for dime-store gliders

What this country needs is a good $5 trainer. With a little work and a small investment in the airframe, this slogan can be realized. Note the exposed rudder pushrod.

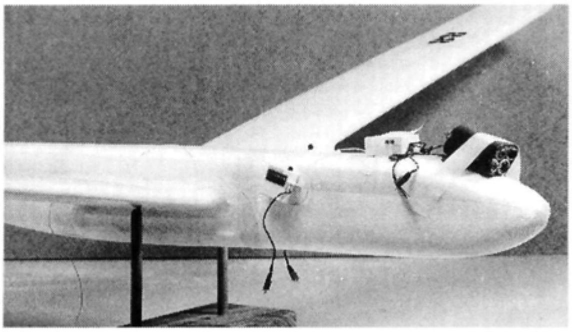
Make an Instant Foam Trainer

by JEF RASKIN



Here are the foam wings and stab for our $5 foam trainer. Notice how the stab is cut to produce a straight trailing edge and that we have removed the sweepback on the wing panels. The wing panel on the left and the left-hand side of the stabilizer is how they come formed, and the right shows the modified part.

"WHAT THIS COUNTRY needs," a long-out-of-date slogan went, "is a good five-cent cigar." But what a beginning flier needs is a good five-dollar R/C primary trainer. It's got to be not only cheap, but also easy to build (one or two evenings) and tough enough to survive lots of crashes. And it's got to be really easy to fly. Looking through slides of my models, I come across a design that I've built again and again over the last 25 years. Another one of them (the 20th? the 40th? I don't know, they're so easy to build that I haven't kept count) sits on my shop wall right now, about to train another season of pilots.



With the wings, stab and control surfaces installed, you can adjust the placement of your radio gear for proper CG location.

While I have gone on to design some far more sophisticated models based on similar construction techniques (the very aerobatic Anabat* series), the models discussed in this article make an excellent and inexpensive powered or slope trainer. It's based on the foam gliders with a $4\frac{1}{2}$-foot span that many toy and hobby stores sell. They cost from $4 to $10. The most widely available model comes from Comet Industries. The semi-scale B-52 from Marchon—appropriately for a heavy bomber—has the densest foam and is best for powered models. The least dense and most poorly cast (and the cheapest I've found: $3.99 at Toys 'R' Us) is the Sky Rider from Life-Like. If you have tiny radio equipment (such as that made by Cannon R/C*), you can even R/C the much smaller Skyraider from North Pacific for slope or .020 engine flying.

To convert any of these planes into good R/C trainers, only a few modifications are required:

- To make the plane balance properly with the radio gear installed, the wing sweep must be mostly removed.
- For strength, the wings are made into a one-piece unit.
- Three-quarter-inch fiberglass strapping tape is used to stiffen the wings and strengthen the fuselage.

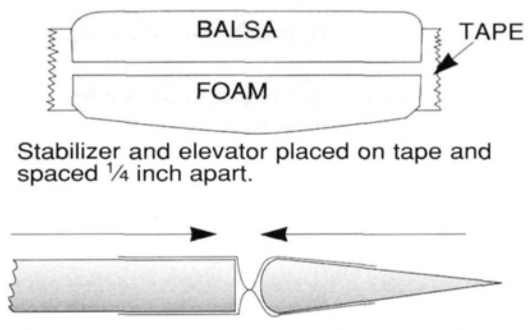
The author's daughter, Aviva, practices her launching skills with an unmodified plane. Adding R/C is really easy.

• The stabilizer is placed lower, and balsa control surfaces are added.

• Radio equipment is installed in hollowed-out pockets, and the servos are connected to the rudder and elevator with external control rods.

THE WINGS

The first step is to remove any lumps, fake engines, or other details that hang out on the wing and fuselage and to fill in any casting marks with lightweight, water-based spackling compound (look in your hardware store). I use a two-grit, tungsten-carbide sanding block from Perma Grit*—the rough side for shaping and the fine side for finishing. Test-assemble the model to see how it was intended to look. The extreme sweep on the stock kit is there to minimize or eliminate the need for nose weights. Since your radio (and, possibly, an engine) will be weighting down the nose, you don't need the sweep. Besides, the sweep can cause a nasty tip-stall.



Stabilizer and elevator placed on tape and spaced 1/4 inch apart.

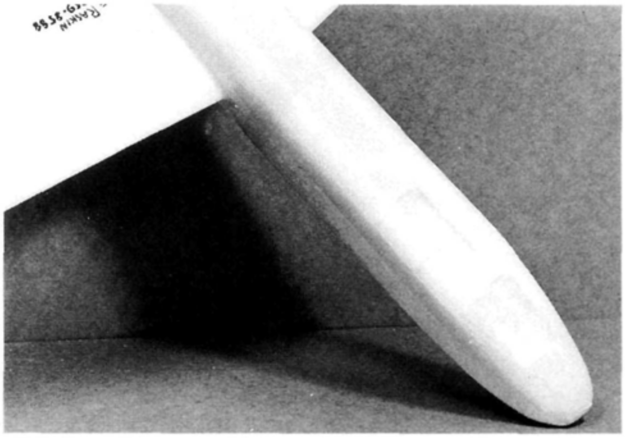
Press the elevator and stabilizer together on a flat surface. The tapes will buckle inward, making a strong hinge when they touch in the center.

The planes will fly much better if the entire trailing edge is feathered, using the sanding block, to about 1/16-inch thickness (it comes about 3/8 inch thick). This is a slow process that, if done without finesse, can end up gouging the trailing edge. So do it carefully. Sand the top only, and leave the bottom flat. Make a smooth curve over the rear half of the wing, not just a sharp bevel at the trailing edge.

Using a hobby saw, trim the wing roots square to the trailing edge of the wing and through the corner where the root meets the trailing edge. This leaves a bit of sweep in the leading edge. Use the sanding block to make sure that when the wing halves are glued together, the trailing edges will lie in a straight line. The dihedral, with one panel held flat, should be between 6 and 8 inches at the elevated tip. When the wing root is correct, glue the wing halves with 5-minute epoxy or (my favorite for the task) Satellite City* UFO foam-compatible CA.

The wing is too flexible as is, so now comes the trick that makes these planes strong enough to fly and last through a season or two (I've had some stand up to beginners for three slope-soaring seasons). A continuous strip of fiberglass-reinforced strapping tape is placed across the bottoms and tops of the assembled wing halves—*applied with the tape under tension*. This essential tension is created by pulling hard (about 30 pounds of pull) while the tape is applied. This is best done by two people: one holds the end down on the wing and the other pulls and presses down the tape without letting up on the tension.

After the first tape has been put on, the wing will bow toward the tape. The second tape, if it is put on with the same tension, will straighten out the bow. After putting on the tape, feel how stiff the wing has become. This use of tape under tension has an incredible effect! The leading and trailing edges of the two wing panels are protected by putting a strip of strapping tape (without tension) around them. The protection afforded by this strip of tape is surprising; don't be tempted to add a balsa leading edge; it turns out to be more breakable that way!



With the radio-gear position established, simply dig out pockets in the foam for the receiver and battery pack. Packing tape is used to seal up the pockets once the gear is in place.

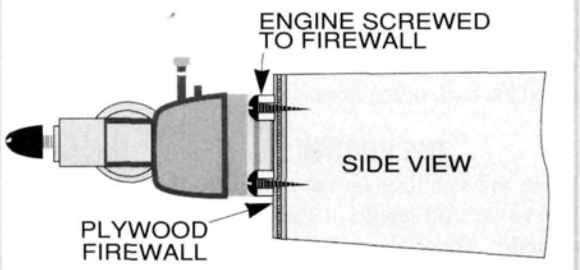
PHOTOS BY JEF RASKIN

THE FUSELAGE

Streamline the fuselage by removing cockpit detail and other draggy design features and spackling in any dents or casing marks. You will have to open up the wing slot so that the entire wing can be pulled through. The fuselage is reinforced by applying strips of strapping tape to the top, the bottom and both sides under tension. Angled strips stiffen the fin, and more strips protect the leading and trailing edges of the fin (as was done with the wing). In a crash, the wing acts as a wedge, trying to split the fuselage. To prevent this, place a band of strapping tape around the fuselage just ahead of the wing and another just behind it.

THE STABILIZER AND ELEVATOR

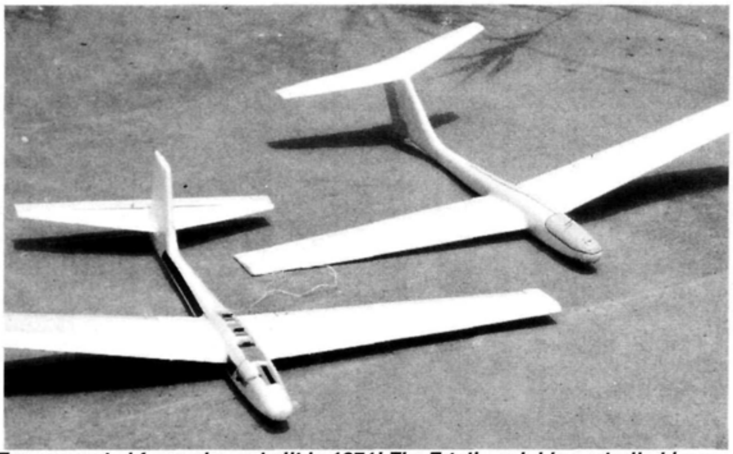
So that you can attach a one-piece elevator, use a razor and a straightedge to cut off part of the trailing edge of the stabilizer so that what is left is straight. Cut off as little as possible to do this. Using some 2-inch aileron stock, make a strip elevator the full length of the stab. I find that Sig's* 2x1/4-inch aileron material is ideal. Sand the stab to the thickness of the balsa part. Add strapping tape to the leading edges and one piece to the top and another to the bottom of the trailing edge of the foam portion.



Engine-mount detail.

To do the hinging, I use the trick developed for the Anabat series. I use packaging tape. Scotch tape 355 in a 2-inch width is perfect for this application. It's about 3 mils thick. Some other brands do not work as well, as they are too thin, too soft, or have an adhesive that, over time, "creeps" and causes the hinge to fail in a few weeks.

Place a strip of tape so that it overhangs the trailing edge of the stabilizer by 1 inch. Turn the stab so that the tape is on the bottom. Place the elevator on the tape so that it is spaced away from the stab by the width of the surface. If the stab is 1/4 inch thick at the trailing edge, then the elevator should be spaced 1/4 inch away from the stab. Next,



Two converted foam planes built in 1971! The T-tail model is controlled by an Ace pulse proportional system and is rudder-only. The other plane uses aileron and elevator control.

put on another strip centered across the top of the gap. This leaves a ¼-inch square "hole" between the two tapes. Holding the stab and elevator flat on the table, push them slowly, but firmly, together. The tapes will fold inward (it seems like magic), touching in the center, forming a sealed, smooth-working, long-lasting hinge.

One of the big problems with these models is that the stabilizer is placed in the middle of the fin. We want it at the bottom of the fuselage so that we can make a rudder the full height of the fin. Carve the bottom of the rear of the fuselage to match the stabilizer. It should be level with the bottom of the wing slot, and just the elevator should protrude beyond the back of the fuselage.

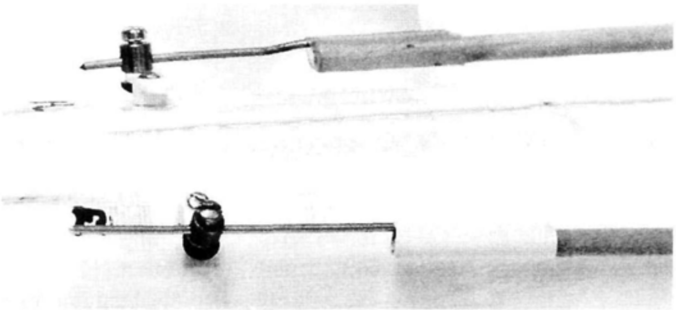
THE RUDDER

We put the stabilizer on the bottom so that we have the full length of the fin to attach the rudder. These planes fly best with a big rudder. A scrap piece of foam can be used to fill in the slot where the stabilizer used to go. Glue in a chunk of foam with Satellite City's UFO CA or white glue, then sand it flush with the sides of the fin. Hinge a 2-inch-wide rudder to the back of the fin using the Anabat tape trick.

An alternative way to power the model: mount the engine (an .049 Cox Dragonfly) on a power pod. It lessens the chance of breaking a prop during a hard landing.

ATTACHING THE WING AND STABILIZER

Here's a secret that took me only two or three years to figure out: foam is pretty soft, epoxy is pretty hard; so when you glue foam with epoxy, there's a good chance of the foam failing right next to the stiff epoxy. So to attach the taped wing, slip it through the fuselage until (1) it's centered, (2) the trailing edge is square with the center line of the fuselage, and (3) the dihedral on both sides is the same. Now stuff some scrap foam plastic to fill the space around the wing, and then use *silicone caulking compound* (white looks best) to fill in and fillet the rest of the wing opening. This stuff is flexible when dry so, in a crash, the joint will give instead of breaking. Glue on the stabilizer at the same time with the same stuff. If the stabilizer is flat on one side and curved on the other, put the curved side *down*. Make the stabilizer parallel to the bottom of the wing as seen from the side and square to the fin as seen from the back. Put in a few pins to hold the alignment, and let it sit for three or four hours before you go back to work on the plane.



Here, you can see the control arms of the servos sticking out of the top of the fuselage. The packing tape secures the servos tightly in place.

ADDING AN ENGINE

Choose an .049 engine with a built-in tank, such as the Cox* Baby Bee or, for longer runs, a Cox Dragonfly (a third servo can be used to operate the throttle on this one). A Tee Dee is too much engine, and you have to deal with tank installation. You can cut 2 inches off the nose, epoxy on a plywood bulkhead and screw on the engine. It's that easy. The fuel will not attack the foam, but if you want to put on a coat of epoxy around the front of the plane, it will help to keep the foam clean longer. A detachable over-wing pod can be used if you will not always fly with the noisemaker.

As gliders, these planes fly much like "floaters." A gentle high-start or hand-tow will get them up, and they're ideal for slope soaring.

RADIO GEAR AND LINKAGE INSTALLATION

These planes are light and fly slowly, so you can just glue the control horns to the rudder and elevator (the UFO will do nicely here, too), not messing around with the little screws. In a crash, they do sometimes pop off, but that's better than breaking a control rod or a servo gear. It takes a few seconds to glue them back on. Think of this technique as the mechanical equivalent of a fuse.

Editor's note: the technique of gluing control horns to balsa surfaces is adequate only for light, all-foam-structure models. Many prefer to use a small, light screw to bolt the horn fast to a backing plate, but this removes the "safety fuse" benefit. We and the author do not advocate gluing control horns to balsa for larger models, models with non-foam fuselages, or models that fly faster than these trainers. In those models, use the supplied mounting plates and bolts.

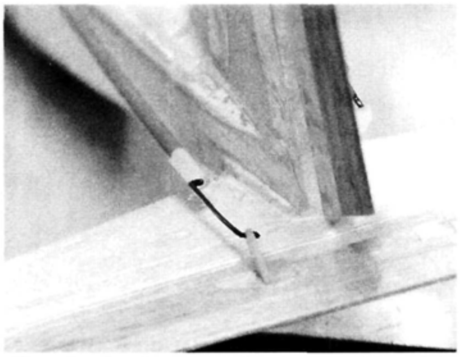
Temporarily use masking tape to attach the radio system to the fuselage for a preliminary balance. The balance point varies but, with most of the models, the balance point is about ½ inch ahead of the center of the wing at the fuselage. You will have to experiment.

It would be hard to make one of these birds hollow, so I just dig pockets into the top, sides, or bottom of the model and put in the 250 to 500mAh battery pack, receiver, and two medium servos or two micro servos. With a screwdriver, dig thin tunnels between the equipment pockets to run the servo and battery leads. Tape over the openings to keep the gear in place. I let the servo arms protrude from the fuselage and run simple dowel-and-wire control rods directly to the rudder and elevator. If you position the ser-

vos correctly, these can be dead-straight runs. Attach the wire-pushrod ends to the dowels with shrink-tubing. The antenna is taped along the top of the fuselage.

The external control rods may seem crude, but they have proven very sturdy and have three major benefits: they are easy to install, easy to adjust, and beginners can see exactly how the control linkage works.

These methods make building an R/C model so simple that once you've done one or two, it takes a single evening to turn out a ready-to-fly plane.



The elevator is made of balsa and hinged to the stab's trailing edge with more packing tape. The control horn is simply glued in place.

FLYING

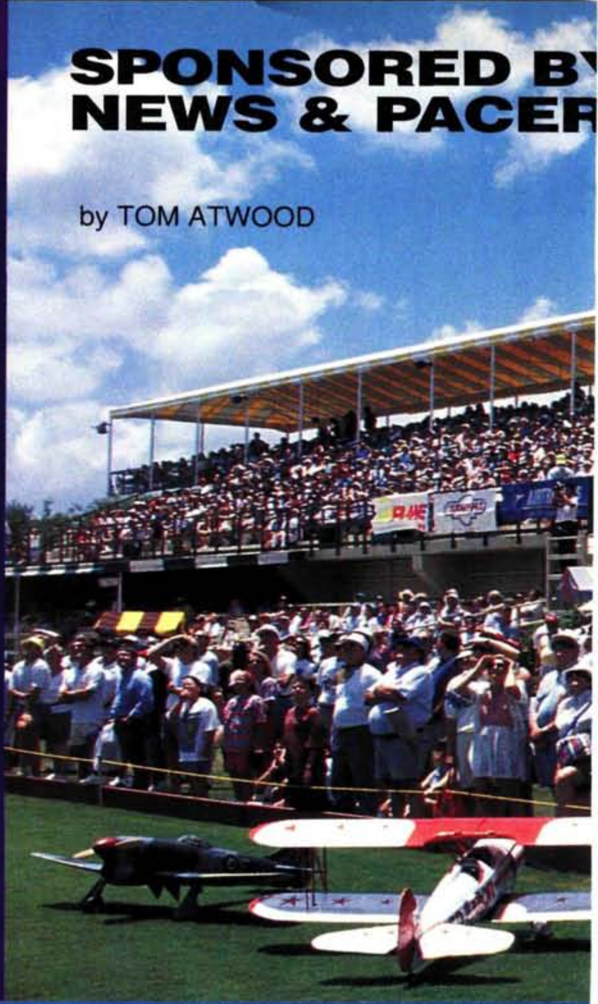
As gliders, these planes fly much like "floaters." A gentle high-start or hand-tow will get them up, and they're ideal for slope soaring. With their small wings and arbitrary airfoils, they aren't thermal hunters, and there's no way they can be considered aerobatic planes (beyond doing loops).

As powered planes, they fly slowly and are easily controlled. With an .049 engine, they can be gradually circled up almost out of sight. When the engine stops, you have a long time to glide back down. I've found that these inexpensive planes are excellent for teaching beginners how to fly, how to launch and how to set up and achieve smooth landings without incurring a severe crash penalty when they goof. For the experienced pilot, these planes are the ideal, "I'll try to fly anywhere" model for those new sites where you don't know what to expect. You're not out a lot of money or time if you do manage to smash it. But doing serious damage is difficult: once I flew one straight into a cinder-block retaining wall. The plane just bounced back, flipped over and skidded down the wall. The nose was a tiny bit flatter, but there was no damage. Try that with most models!

**Addresses are listed alphabetically in the Index of Manufacturers on page 137.* ■

6TH ANNUAL TOP GUN SCALE INVITATIONAL

The pinnacle of scale modeling



SPONSORED BY NEWS & PACER

by TOM ATWOOD

Center: Terry Nitsch's 1/5 scale, BVM F-86F Sabre, which took 1st place in Expert and also Best Craftsmanship, looks great in the air and equally impressive on the ground. The 14-pound plane has a 58-inch wingspan, a BVM .91 engine, McCoy plug, Viojett fan, a JR PCM 10S radio, Aeroloft and Dry-Set markings, and drinks JP-4 fuel. The plane carries a Glennis nose wheel and BVM mains. Upper left: Terry and his wife and pitcrew member, Sheila, share the limelight in the winners' circle. Terry is no stranger to competition: he was Top Gun runner-up in '93, Masters winner in '92, Masters runner-up in '93 and winner in Expert Sport Scale at the AMA '93 Nats. Word has it, he may share some of his scale finishing secrets with us in upcoming issues. We'll keep you posted. Right middle and bottom: detail shots show the Aeroloft markings on the fuse; cockpit markings were handmade by Terry.

Top Gun '94, held from April 28 to May 1, was the fourth Top Gun to take place at the West Palm Beach Polo Club in West Palm Beach, FL. The flying field is a site of exquisite elegance and beauty. The huge polo field, with its well-manicured, closely-cropped grass (and temporary, alternate runways) is a fitting venue for the exhibition of "scale masterworks" that represent the pinnacle of achievement in the scale modeling world. The concession stands, vendor booths and comfortable facilities make the site a pleasure for spectators as well.

ODEL AIRPLANE
CHNOLOGY

Generali, who
Tom Robertson
2nd in Team, flies
VM F-80 ducted
atty, an excellent
is assisted by her
, Bob Violett.

Bob Pickney and Dean Digiorgio won 1st place in team with their 42-pound, Twin Beech D-18 built from Nick Ziroli plans. Two G-38 engines spinning 20x8 props pull this sizeable model through the air under guidance from a Futaba radio. The balsa and ply aircraft is covered with Ceconite and finished with PPG acrylic lacquer paint and Zap finishing resin. The ship includes CB wheels and Robart retracts.

A scene oft repeated on the flight-line—in a preflight contest routine, flight judges are shown the plane's functions. Here 2nd place, Expert and Best Jet Award winner Garland Hamilton demonstrates landing-gear deployment and retraction.

Nick Ziroli, Jr. in the middle of flight competition; his caller is Nick Ziroli, Sr.

Below: the crowd, mesmerized by lunch break exhibition flying, presses the outskirts of the flight line.

Above Garland Hamilton's 1/6-scale P-80 won 2nd place, Expert. The 16-pound plane is powered by a BVM .91 engine spinning a Viojett fan. JP-4 fuel. McCoy plug.

Right: Staff photographer Walter Sidas catches Jerry Caudle's BVM Maverick Pro in a slow fly-by. If you're interested in starting out in ducted fans, this is the BVM trainer aircraft.

TOP GUN

Dave and Tony Malchione took 4th place, Team with their beautiful BVM T-33. It's powered by a BVM .91 engine and Viojett fan; JP-4 fuel; McCoy plug; BVM retracts.

For a period each day, spectators are allowed onto the flight line during a model lineup. When you visit Top Gun, be sure and bring your camera!

Top dog Frank Tiano (middle right) assists Kerry Sterner (middle left) in setting the needles on Kerry's awesome, precision scale Beechcraft Starship. Unfortunately, technical problems kept the plane out of the air except for one fleeting moment. The 43-pound, 1/5-scale masterpiece is controlled by an Airtronics radio and powered by two SuperTigre 2500s in pusher configuration, spinning Zinger 18x6 propellers.

Right: Cliff Tacie's 1/11 scale SM-18 is readied for flight competition. The 16-pound plane is powered by three K&B .21s spinning Master Airscrew 9x4 propellers.

Chuck Fuller's smart-looking Ryan PT-22 was scratch-built from Bob Sweitzer plans. The 27-pound plane is powered by a G-62 spinning a Zinger 22x11 propeller; fiberglass fuselage; fabric-covered foam wings; and Du-Bro treaded wheels. Chuck, as always, offers some scale modeling hints: look for stitching for cockpit coaming by surveying inexpensive ladies purses, and apply the coaming with Zap-a-Dap-a-Goo; use the concave bottoms of aluminum pop cans for hubcaps. We're listening, Chuck!

Platt's Magnificent Mohawk

Dave Platt's eye-catching Grumman Mohawk OV-1D, winner of the Critics' Choice award (Dave received an Airtronics Infinity radio and a trophy) created a lot of interest at Top Gun. The 15-pound, all-balsa airplane—an obviously stable flier—was propelled by two inverted, 4-stroke Enya .53s spinning APC 12x6 propellers. It featured retracts and was finished with K&B resin primer (and paint) over Dan Parsons' 0.6-ounce fiberglass cloth. Note the side-looking airborne radar pod (SLAR). In the course of building this magnificent machine, Dave solved a few modeling problems in ingenious ways.

The inimitable Dave Platt—aviation authority, accomplished announcer and master scale scratch-builder/designer—sits behind his Grumman Mohawk OV-1D. It was destroyed in a midair, but a larger version will be flying, Dave promises, by the time this is in print.

I spoke to Dave and caller/mechanic Dave Fogarty to get the details.

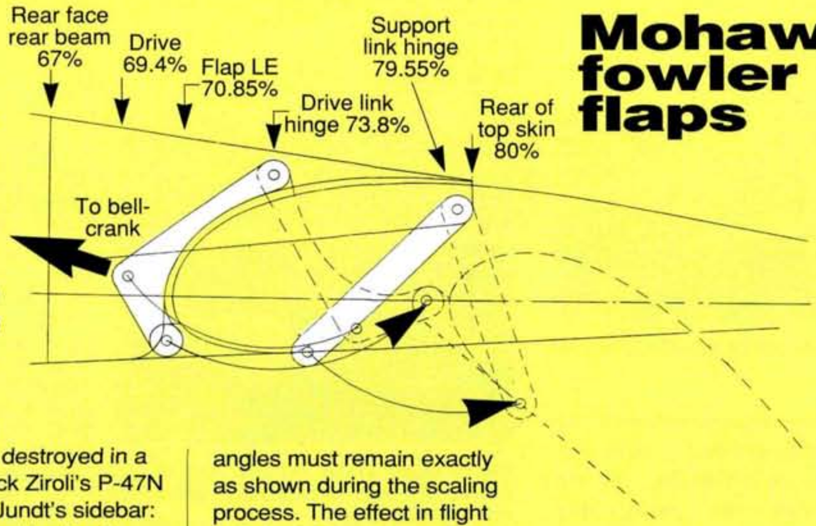
FOWLER-FLAP SOLUTION

How do you engineer a set of flaps that slide back and angle downward at the required 40-degree angle and then retract nicely? If you want to actuate the flaps mechanically (thus avoiding

Charlie Nelson's 1/4.25 scale, entirely scratch-built WACO VKS-7F, the '92 Top Gun winner in Expert, took a respectable 9th place this year. It is powered by an impressive Seidel 7-cylinder engine (Proctor) and weighs 30 pounds.

Stephan Dürrstein (right) and Stefan Bloss (left) are interviewed by editor Tom Atwood. The glorious 1/9-scale DC-3 was powered by two O.S. 70 4-strokers spinning Graupner 11x7 propellers. The 28-pound plane had a tragic first flight at Top Gun '94, during which the converted (from 35 to 72mhz) Multiplex radio lost contact with the plane, and it rolled and nosed in right after takeoff. The mainly fiberglass plane (ply struts and some custom aluminum hatches) earlier received high static in civilian scale at Hausen, Switzerland; it was built from a Fiber Classics kit designed by Andreas Gietz.

Mohawk fowler flaps



the complexity of a pneumatic system), what kind of servo do you need? Dave Platt faced this challenge recently when he scratch-built the Grumman Mohawk that was tragically destroyed in a midair with Nick Ziroli's P-47N (see John E. Jundt's sidebar: "Second Thoughts about Some Firsts"). Dave's elegant solution—which reportedly entailed some 80 hours of development effort—relies on a single Airtronics coreless servo to deploy and retract both wing flaps. The geometry of the mechanism does not permit aerodynamic forces acting on the deployed flaps (or accidental bumps and dings) to feed back to the servo, so you don't have to worry about stripped gears.

Dave comments: "Note that the drawing can be scaled up or down according to the chord required. For the mechanism to work properly, all angles must remain exactly as shown during the scaling process. The effect in flight with the Mohawk is a slight but manageable nose-up pitch-trim change. Some transmitters have the ability to handle this pitch-trim change by mixing in down-elevator trim (the amount can be dialed in) when flaps are deployed. Needless to say, all parts have to be made with absolute precision for the assembly to work properly." We are impressed! Will we see mechanical Fowler flaps on more models in the future?

MANAGING INVERTED 4-STROKERS

Dave uses onboard glow drivers that are tripped by a mechanical arming switch when the plane is flown at less than half throttle. Despite their inverted positions, he worked out a foolproof system for starting the Enya .53s. Here's his technique:

- Fuel up and pinch the feed lines with hemostats.
- Swing the throttle stick to high.
- Toggle the glow-driver arming switch to the "on" position.
- Start to turn the first engine over with a torque starter.
- Pull the throttle switch back to low throttle, which lights the glow plugs.
- Pull the hemostat off the fuel line and—presto!—the first engine will start reliably. Turn the second engine over, pull the hemostat off, and you're ready to fly.

Note the buttons on the end of control sticks on Dave's microPro-8000—they control bomb drop and retracts.

USING THE STICKS

Dave contracted with Ace R/C to mount special switches (custom-made by Dave) on the end of the control sticks on his microPro8000. Pushing the button on the end of one stick triggers the bomb-drop command, and pushing the other deploys the retracts. This is quite nice for scale modelers, but I think any modeler could benefit from this handy feature. Any manufacturers listening?

The weather was gorgeous (although the flying field, somewhat dampened by preceding rains, proved to be a ROG challenge this year for some higher-wing loaded, smaller-wheeled fanjets). In expert, 47 scale aircraft were entered, in Team, 15 (one in four planes participating was a 4-stroke; see John E. Jundt's sidebar, "2 Plus 2 Equals 5").

After a day of orientation, two days of static judging were followed by two days of flight judging. As luck would have it, a mild crosswind blew into the faces of pilots for the first couple of days—it only added to the excitement! But conditions improved as flight competition opened up (pilots used the alternate runways, set at 45 degree angles to the main, as needed).

Mark Frankel's Skyray drops its tanks in a flyby piloted by fellow team member Bob Fiorenze. The plane, which was featured as a construction article in the April '93 issue of Model Airplane News, came in 9th in Team. Scratch-built from Frankel plans, the 18-pound plane carries Platt retracts and is powered by an O.S. .91 fan engine that spins a Ramtec Fan. Glennis wheels top off this elegant scale model.

Kerry Sterner's Beechcraft Starship hopped into the air when hit by a sudden gust of wind, even as Kerry had dropped off the power to enable the nose to rise. But the gust hit before true air speed had been attained. The ensuing hard landing damaged the nose-gear mount and the plane was out of the flight competition. We believe this bird will soon be flying high in scale competitions. Look forward to seeing more on it in Model Airplane News.

More camera opportunities at the flightline lineup.

TOP GUN

Bill McCallie's 1/5-scale P40E Aleutian Tiger has a wingspan of 80 inches; Enya V-240 engine (inverted mount with Radio South glow driver and ignition); Zinger 18x10 prop; and is flown with a Futaba 9VAP radio. The plane carries Platt retracts that have been modified to rotate 90 degrees during retraction. Bill indicates an article detailing the mod will be coming our way—we'll keep you posted.

Photo left: Bob Violett (left), Jerry Caudle (middle) and a fellow team member check out Bob's new twin-engine F-4 before flight competition. Above: the 24-pound aircraft is powered by two BVM .91 engines turning Violett fans; JP-4 fuel; McCoy plugs; Violett retracts; and JR radio. Minor technical glitches caused the team to zero out in some rounds, but the prototype flew very impressively.

We have done our best, in this article, to highlight some of the notable solutions to mechanical and design challenges that were in evidence at Top Gun '94. We hope you enjoy this glimpse of "the tip of the iceberg." To learn more about these awesome models, you'll want to attend the next Top Gun in person, if you can. You won't be disappointed!

Jeff Foley's 1/5.5-scale, 18-pound A6M3 Zero took 3rd in Expert. If you think this picture is pretty, you should have seen it up close! Built from a Dave Platt kit, the plane is powered by an O.S. 1.08; APC 15x8 props; JR radio; Omega 10-percent fuel; and Fox plug.

THANK YOU

Many contributed to Top Gun besides the major cosponsors, Pacer Technology (manufacturer of Zap adhesives) and *Model Airplane News*. First, we would like to thank Frank Tiano Enterprises—the driving force behind Top Gun—for

Chip Hyde flies a Lanier 1/3-scale Laser in a close-in, low knife-edge exhibition pass.

Second thoughts about some firsts

A first for this year's Top Gun was its own Watergate—or should we say "Raingate." Upon arriving Wednesday, it appeared to me that Top Gun might be rained out for the first time ever. The weather bureau stated there had been 5 inches of rain on Sunday, 1 inch on Monday, 1 inch on Tuesday, and 1½ inches on Wednesday before the showers decided to move on and haunt outdoor activities elsewhere.

When one stepped on the fantastically level polo field early Thursday morning under gloomy skies, one was greeted with water levels that lapped over the edges of one's sneakers. No way would there be a flying Top Gun this year. Knowing Frank Tiano's versatility and inherent flexibility, this year would undoubtedly be a boating event. Right? Wrong! The Polo Club's magnificent maintenance men and their wonder machines, along with members of the Palm Beach Aero Club, worked all day Thursday and, by Friday morning, with the sun threatening to peek through, the site was flyable, and the 1994 Top Gun Invitational was off and running (see photos at front of article).

This year's Expert Winner was Terry Nitsch, flying a BVM F-86 fan jet. This win marks the first time a jet has won at Top Gun since it has been held at the Palm Beach Polo Club. Terry won last year's Best Craftsmanship award, and he repeated by also winning this year's Dry-Set Best Craftsmanship award, which is the first time anyone has won this coveted award two years in a row at Top Gun.

This year's Top Gun marked the first time that a new award was given: the Glen Torrance Models' Highest Cumulative Flight Score for all four rounds. Mr. Nitsch also walked away with this award.

Above: Kent Nogy's BVM T-33 is the first JPX T240 turbine-powered scale competitor in U.S. history. The 18-pound, propane-drinking aircraft has an 80-inch wingspan, and it's said to run relatively cool because of the turbine installation and ducting design. The 3¾-pound turbine engine propelled the plane with ease (the propulsion unit with support components and fuel has an all-up flying weight of 5¼ pounds). A kerosene-drinking version is in development.

Left: on the flight line, Bob Violett, Kent Nogy and J. Buchoux preflight the T-33. The turbine is spooled up with the help of a pressurized scuba-diving tank.

MIDAIRS

Think of the odds of this happening: two planes in level flight, traveling in opposite directions, cross center field; both pilots decide to do a graceful, climbing split-S. Up the hill they go to great heights—roll, pull, back to horizontal and level flight at the mid-field entry point and—*wham!* They center punch each other, nose to nose, into total destruction. The 1/6-scale, 24-pound, P-47 was built and flown by Bill Carper. The 1/6-scale, 25-pound SBD-5 (what remained of it) had been built and flown by Mel Whitley. Next day, another midair occurred, this time between David Platt and Nick Ziroli Sr. David was flying his new, all-balsa, scratch-built, 1/7-scale, 15-pound Grumman Mohawk OV-1D, with which he had just won the Best Military award. Nick was flying his 1/7-scale, 16-pound P-47N. The planes were in level flight, coming in

Scale insignia secrets

Claude McCullough scratch-built this plane from his own plans. It has won him three QSAA trophies in addition to his latest Top Gun accolades. How was the insignia created? The original scale subject was owned by Len Povey, a racer, stunt flier and aviation adviser to Cuban dictator Batista in the '30s. Claude blew up a photo of the insignia to 20 inches in length, placed clear Mylar over it and traced the outlines in black ink. He flopped the Mylar for the other side of the plane (except for the medallion) and photo-reduced the image to scale size for his model. Aeroloft converted the design into a rub-on decal. He gave the aircraft a white undercoat and rubbed on the decal, hand-painted the insignia (airbrushed colors) and then, to clean up the edges, put another Aeroloft rub-on of the insignia over the painted insignia. Although Aeroloft decals are soluble in dope, he misted on fine coats to avoid any problems. He also used Dry-Set rub-on markings elsewhere on the plane (not soluble in dope), and the result won him and fellow team member, Bruce Tharpe, two prestigious awards.

Claude McCullough (our 10th AMA president) and Bruce Tharpe entered this beautiful ¼-scale, Saito 300-powered (Zinger 20x8 prop) WACO D in Team—and took third place as well as Best Biplane. The 32-pound bipe is controlled by a Futaba radio, and it uses five channels (the fifth for bomb drop). A ¼-inch rudder deflection is coupled to ailerons for better turns. Construction is mainly balsa with some ply and spruce, and the plane is covered with Sig Coverall and painted with Sig dope.

opposite directions, approaching mid-field in front of the judges and—*blam!* David's airplane was absolutely totaled. The integrity of Nick's airframe remained somewhat intact, and, through expert piloting skills, he was able to land without total annihilation. Nick was able to repair his airplane and limp on with the competition to finish 22nd overall.

TURBINE IN COMPETITION

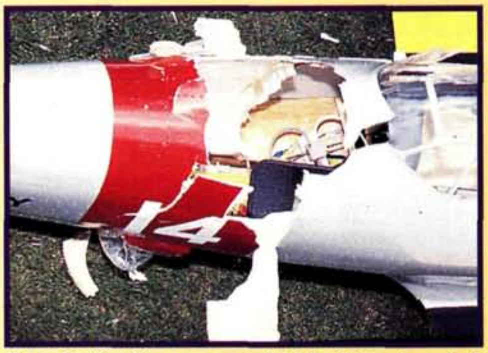
Kent Nogy flew a BVM T-33 jet powered by the JPX Turborec T240, propane-fueled turbine engine. This marks the first time a true turbine engine has been entered in competition in the United States, and it happened at the 1994 Top Gun Invitational.

The first time one flies a fan jet one might as well do it in competition, at least if one's name is Chip Hyde. Chip showed up as a pilot teaming up with builder Don Kanak to enter Team Scale and fly their Yellow Aircraft F-18. After having a zero first round and only a 69.8-second round, they performed well enough in the next two rounds to finish a respectable seventh. During the noon exhibitions, Chip also flew exciting and crowd-pleasing demos with a Lanier aircraft . It might be a dubious first timer but, for two years in a row, residents from the same state—Ohio—won the Top Buns award given by the Top Gun Hussies Group. Shows you what sharing those "Buns of Steel" video tapes can accomplish.

—John E. Jundt

Nick Ziroli's 1/7-scale P-47N is pulled by a Zinger 18x8 prop motivated by a Quadra 35. A Futaba radio controls the aircraft, which escaped serious injury in an airborne encounter with Dave Platt's Grumman Mohawk. The 16-pound plane has Century Jet retracts with Robart struts and, of course, was built from Nick Ziroli plans. In the background sits Dave Voglund's 1/5-scale SNJ-5 (also built from Ziroli plans), which took 12th place in Expert. The G-62-powered ship spins a Zinger 22x10 prop.

Chip Hyde and Don Kanak campaigned this impressive Yellow Aircraft F-18 ducted fan. Two O.S. .91s spinning Dynamax fans propel this 98-inch-long aircraft. Early in the competition, the Yellow Aircraft retracts kick up damp grass on a landing.



Dave Voglund's compressed-air tank (made out of a plastic soda bottle) burst with a loud report that, to those nearby, sounded like an M-80 going off. The heat generated in the fuselage by the Florida sun is evidenced by the shriveled remnant of the plastic vessel inside. Don't let this happen to your scale model!

Two plus two equals five

Kim Foster's ¼-scale, 16½-pound Nieuport 28, built from a Proctor kit, took 10th place in Expert. It's powered by a YS 1.20 4-stroke that turns a Zinger 16x8 prop; Cool Power fuel; and O.S. plug. It has an 80-inch wingspan and is finished with automotive lacquer.

Is there a 4-stroke engine in your future? It would appear that 4-stroke engines have reached a synergistic datum where the total is now greater than the sum of the individual parts. Until recently, the FAI has placed restrictions on 2-stroke displacement for certain classes of competition so that 4-stroke engines might have a fair

Corvin Miller took 5th place, Expert, with his scratch-built 22-pound, ¼-scale Globe Swift. The '93 Top Gun winner in Expert, the Swift has an 80-inch wingspan and is powered by an O.S. 1.60 that turns a Zinger 16x6-10 prop; Pro Power fuel; O.S. plug; and Airtronics radio.

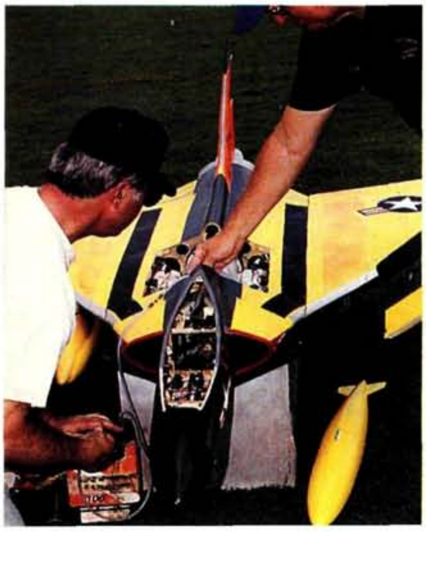
A municipal airport? No, just the classiest all-grass R/C flying field we have seen—but what else would you expect from Top Gun?

PHOTO BY DUNN'S AERIAL PHOTOGRAPHY, INC., WEST PALM BEACH, FL.

Patty Generali, who with Tom Robertson (builder), took second in Team with a BVM F-80, smiles in the winners' circle. She continues to be the most active female scale competitor and ducted-fan pilot in the U.S. The plane features a Kansas Tornado paint scheme (Dry-Set markings).

Below: Roy Vaillancourt's gorgeous Sea Fury flies in ground effect. The all balsa and ply, scratch-built prototype for a Vailly Aviation kit has a 90-inch wingspan and is powered by a Sachs 3.7 spinning a Zinger 22x10 prop. The 38-pound aircraft uses Hank Likes' electrical retract mechanisms, combined with scratch-built struts. Roy was not concerned should the weather threaten to sprinkle—the plane is painted with Benjamin Moore latex exterior house paint! Chrome HobbyPoxy paint was buffed to simulate metal exhaust finish; markings from Clyde Geist of AMP Graphics.

Above: Jim Wilkinson's impressive 21-pound, ⅙-scale JU87-B was scratch-built from his own plans. The plane noses down, opens its dive brakes and then releases its bomb in a seamless scale maneuver. Powered by a G-38 that turns a Zinger 18x6-10 prop and controlled by a Futaba 7UAF radio, the plane has a wingspan of 91 inches. The plane features all-balsa construction and is finished with ½-ounce K&B cloth.



Left: Mark Frankel (left) and pit crewman Gary Cramer prepare Mark's F4D-1 Skyray for flight competition. Mark and Bob Fiorenze (pilot), took 9th in team with this ship. Mark notes that the plane is currently being outfitted with a kerosene-fueled turbine designed by Jeff Seymour. We'll keep you posted.

putting this event together. Thanks to all the Top Gun judges and staff, Tim O'Conner, site manager of the Palm Beach Polo Club, and the Palm Beach Aeromodelers, who hosted the event.

Sam Wright and Dave Platt once again filled the air with humor as well as helpful, entertaining commentary on competing planes and contestants. Our appreciation also to: Jim Dunn, who flew a full-scale, smoke-belching Pitts Special during the opening ceremonies; Don Muddiman and the Cloud Dancers, who dazzled the crowd; Kent Nogy for his demonstration of the turbine-powered BVM Turbo Viper (clocked at 226mph); Jim Florio, for his eye-opening antics with a competition fun-fly sport design; Jeff Combs, a TOC competitor, who flew his Ultimate Bipe the way only fliers of his caliber can; Chip Hyde, who, the very first time at the sticks with the new Lanier ⅓-scale Laser, proceeded to astonish everyone with his virtuosic thumbs; Bubba Spivey and Wayne Voyles, who again flew their Lanier Stingers in a smoke-filled duet that can only be described as both beautiful and majestic; Terry Nitsch, who demonstrated the BVM Ultra Viper ducted

chance. Now, those restrictions are being removed so that 2-strokes can compete with fours.

Four-stroke engines are becoming more powerful and quieter with each new generation of development. Pattern fliers report that the recently released YS 90 is more powerful than the original YS 120. The new 4-strokers find themselves on a par with 2-stroke powerplants owing to the introduction of high-lift cams, larger valves and timing changes. Pressure chambers and superchargers show up on some of the 4-strokes. As evidenced by their new, innovative mufflers, Saito's sound-reduction technology continues to lead to the development of quieter, more effective 4-strokes.

The realistic sound of the 4-stroke engines, coupled with their efficient fuel draw and high torque at low rpm, make these engines perfect companions for scale modelers. This development was shown at Top Gun, as the engines of choice for 30 percent of this year's prop-driven entries were 4-stroke. Of these, six were twins (one Saito 300T, three O.S. 160 Gemini Twins and two Enya V-240 twins), and the rest ranged from .53 to 1.50ci displacement.

Models ranged in weight from 12 pounds (David Haynes' 82½-inch Ayres Thrush crop duster with an O.S. 91 swinging a 15x6 Zinger) to 32 pounds (Claude McCullough's Waco D-5A using a Saito 300T). Other modelers who chose to go 4-stroke engines this year included Mike Barbee, Kim Foster, Andreas Gietz, Bob Hanft, Skip Mast, Bill McCallie, Corbin Miller, David Platt, Tom Polapink and Bob Roan.

The Top Gun judges liked the performance and flight realism of the 4-strokes and their pilots. Five of the top 10 positions in the Expert class and one out of five in Team were won by aircraft dutifully tractored along with responsible 4-bangers. Way to go, 4-stroke! *—John E. Jundt*

fan (clocked at 221 mph); and Andreas Gietz, who, in his own impressive European style, wowed spectators and contestants alike with his three-cylinder, radial-powered Yak (the 3W engine spun a 30x30 prop, and was *very quiet*—engine and plane are offered in the U.S. by Desert Aircraft).

The across-the-board sportsmanship of Top Gun was evident on many levels, and there were numerous, outstanding examples of engineering, artistic and flying accomplishments. If you have the time, why not visit the next Top Gun in '95? If you're a modeler or if you just have an interest in aviation, you'll find this event a winner.

TOP GUN T-SHIRTS

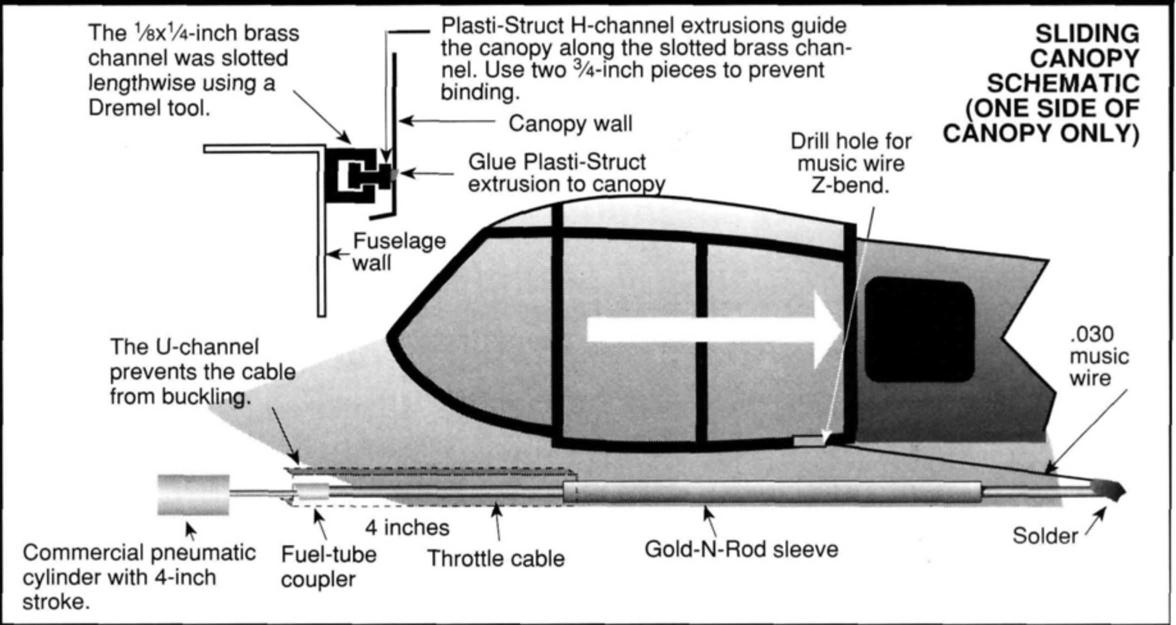
Incidentally, there are some Top Gun '93 as well as '94 T-shirts left, which we were asked to note, so whether or not you were among the approximately 15,000 attendees that attended each of the last two years, if you want to *look like* you attended, you can order them from the Palm Beach Polo Club for $10 and $14, respectively, post age paid. Just call (407) 790-6975.

Sliding canopy

When we saw Nick Ziroli Jr.'s canopy slide back as the gear on his Hellcat extended, we knew there was an interesting mechanical explanation. Nick's mechanism uses a throttle cable to push/pull the canopy along a 4-inch track that he fashioned out of brass channel stock. A U-channel piece at the front end prevents the exposed 4 inches of cable from buckling under compression. At the aft end, a piece of piano wire is angled back to hook into the canopy wall. The mechanism, which is mounted on one side of the canopy only, has operated for many flights with no sign of wear or failure.

Above: Nick Ziroli Jr.'s F6F-3 Hellcat took fourth place in Expert. It's powered by a Sachs 5.2 engine that spins a Zinger 24x14 prop, and it has a 94-inch wingspan. The plane features Robart retracts, a fiberglass fuselage, built-up wings and tail feathers, and it's painted with acrylic lacquer automotive finish. Functional scale exhaust means the exhaust stains on this model are real!

Left: check out the scale exterior of the sliding canopy on Nick Ziroli Jr.'s 1/5.5 scale F6F-3 Hellcat.



TOP GUN

Top Gun standings

Pos./Pilot	Model	Score
1 Terry Nitsch	F-86F Sabre	186.075
2 Garland Hamilton	F-80	183.532
3 Jeff Foley	A6M3 Zero	182.949
4 Nick Ziroli Jr.	F6F-3 Hellcat	181.325
5 Corvin Miller	Globe Swift	180.783
6 David Hayes	Ayres Thrush	179.866
7 Mike Barbee	deHavilland DH-82	179.783
8 Bill McCallie	Curtis P-40E	175.492
9 Charlie Nelson ·	Waco VKS-7F	178.949
10 Kim Foster	Nieuport 28	178.908

TEAM SCALE

Pos./pilot/owner	Model	Score
I Dino DiGiorgio/Bob Pickney	Twin Beech D-18	181.824
2 Patty Generali/Tom Robertson	F-80	180.616
3 Bruce Tharpe/ Claude McCullough	Waco D	179.741
4 Dave Malchione/Tony Malchione	T-33	179.366
5 Lee Rice/Ed Newman	KI-61 Tony	177.450

SPECIAL AWARDS

Critics' Choice—Dave Platt: Grumman Mohawk
Best Graphics & Markings—Bill McCallie, P-40
High Static—Dennis Crooks, Lear 35
Best Jet—Garland "Golo" Hamilton, F-80
Best Civilian—Mike Barbee, Tiger Moth
Best Biplane—Claude McCullough, Waco D
Best Craftsmanship—Terry Nitsch, F-86
Best Military—Dave Platt, Mohawk
Engineering Excellence—Bob Violett and Jerry Caudle, F-4
Top Buns—Kim Foster

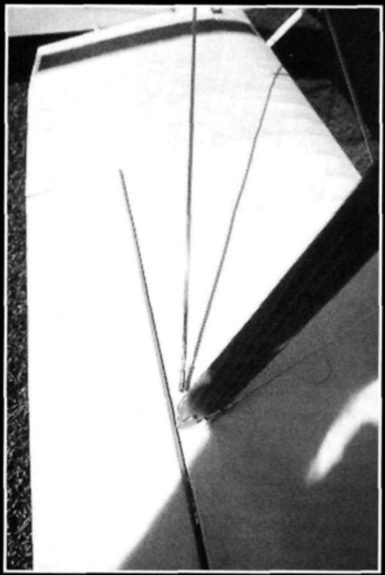
Senior editor Chris Chianelli and Top Gun's Frank Tiano cruise the flight line.

Top Gun '94 sponsors

COMPANY	DONATION	AWARDED FOR/TO
Airtronics	Infinity Radio & Trophy	Critics' Choice
Aeroloft	$200 gift cert. & trophy	Best Graphics & Markings
Aeroplane Works	P-61 Black Widow Kit	Aero Club Raffle
Appian Inc.	Vacuum-forming machine	High Static
Bob Violett Models	BVM $500 Gift Cert. & trophy	Best Jet
Bryon Orginals	$200 cash & trophy	Best Civilian
Dave Platt Models	Jungmeister kit	Best Biplane
Dry-Set Inc.	$200 cash, $100 cert. & trophy	Best Craftmanship
Eagle Editions	3 Crandall art prints	Best Graphics, Best Military, High Static
Frank Tiano Ent.	cash, trophies	management contestants and category winners
Fiber Classics	(Andreas Gietz) Glass Spitfire	Best Military
Futaba	7-ch. PCM Radio	1st Place Team Scale
Glen Torrance Models	$200 cash, trophy	Highest Accumlative Flight Score
FTE	"Bulldog" Retracts	4th Expert
Hitec Inc.	6-channel pro radio	2nd team scale
Horizon Hobby Dist.	JR 388 radio	1st expert division
ISC/Indy RC	Zenoah G-38 engine	5th expert
JR Radios	JR Sport Radio	Best Buns
K&B Mfg.	2 K&B .40 & glow plugs	Palm Beach Aeroclub workers
Lanier R/C	Stinger kits	Aeroclub workers
Madden Model Supply	KI-61 Tony kit	3rd expert
Midwest Products	T-6 kit	2nd expert
Model Airplane News	cash, magazines, subs, T-Shirts	judges, contestants, spectators
Moki/Gerard Ent.	Moki 1.8 engine & trophy	Best 2-stroke performance
Nick Ziroli Models	P-61 plans, cowls & accessories	Aeroclub raffle
Pacer Technology	cash, hats, glue kits, trophies	judges, contestants, club members
Propwash Video	$200 cash, trophy, tapes	high static score & spectator gifts
R/C Report Magazine	$200 cash, trophy & gift subs	Best Biplane
Robart Mfg.	$500 gift cert. & trophy	Engineering excellence
Saito Engines	Saito 1.50 engine	Best 4-stroke performance
Scale Model Research	assorted gift certificates	6th—10th expert
Top Gun Hussies	trophy & zap pack	Best Buns
Zap Gang	glue kits (Zap Packs)	all contestants
Zap Gang	trophies for mass launch	1st—3rd
Proctor Ent.	Eindecker E-3 kit	Best Buns

Low-buck flying wires

Mike Barbee's ¼-scale deHavilland DH-82 Tiger Moth has an 88-inch wingspan and is powered by a Laser 150 engine that spins a Zinger 16x8 prop. Dry-Set decals set off this 15-pound beauty, equipped with retractable slots (upper wings), which was built from Duncan Hutson plans. Mike took seventh place in Expert and won Best Civilian Biplane for his efforts. He controls the ship with a Futaba ZAP1024 radio. The flying wires (see photo detail) were made out of 3mm clock-spring wire that Mike stretched on a vise, soldered links to and then had chromed—all for around $30!



The flying wires were made out of clock-spring wire—another example of Top-Gun-level ingenuity!

Mike stands by his plane during Static judging.

TOP GUN TOP BRASS

Chief static judge— Tim Farrell
Static judges— Bob Curry, Lee Henderson, Bill Deverna, Al Tuttle, Charlie Beer, Manny Rivera
Chief flight judge— George Leu
Flight judges— Jim Semonian, John Smith, Wayne Frederick, Darlene Frederick, Stan Alexander, Tom Kozel, Bob Campbell, Jim Parker
Head scorekeeper— Rosella Curry
Contest directors— Frank Tiano, Joe Manzella

Lumina

Quality Fiberglass

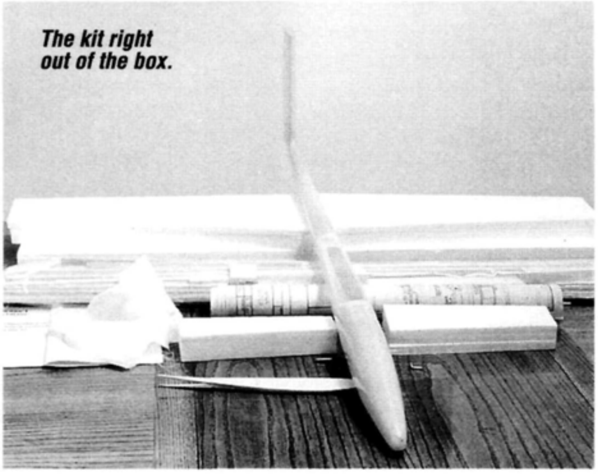
An all-around 2-meter competition sailplane

MODEL AIRPLANE NEWS MAGAZINE FIELD & BENCH REVIEW

by LEE CORNELIUS

AT THE END of my first season of entry-level, 2-meter sailplane competition, I sat down to evaluate my performance. In my first contest, I placed in the top 10; during the rest of the season, I dropped back to the middle of the pack. I concluded that it was time for a new sailplane. My old bird didn't handle well in thermal turns, and I was getting mixed results with spoilers in the landing circle.

PHOTOS BY LEE CORNELIUS & TOM KUSTES



The kit right out of the box.

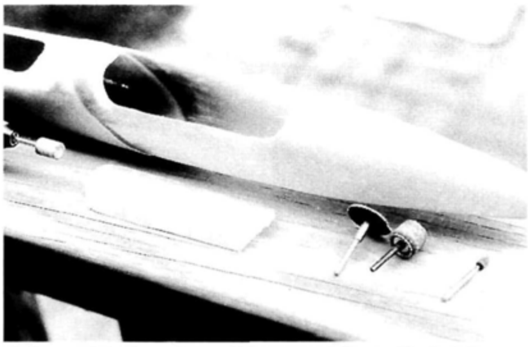
I began to look at the floaters and the heavier full-house ships in the 2-meter class. The Quality Fiberglass* Lumina—a middle-of-the-road sailplane—really interested me. You can build it as a floater with flaps or spoilers, or you can build it as a full-house ship with aileron, flaps, elevator and rudder. If you want to make the investment (and prices continue to come down), use a programmable radio for crow and mixing; you'll have a super-competitive thermal sailplane.

THE KIT

My Lumina arrived in a large, plain box. Like a kid on Christmas morning, I tore into it and pulled out a nice hand-laid epoxy/glass fuselage with a slip-on nose cone; a large bag of hardware and the smaller wooden pieces; and the three-piece foam-core wings, the stab and the rudder cores. Builders who have some experience will find that the six-page instruction booklet is helpful; however, owing to the lack of photographs and illustrations, beginners might find it slow going. The two sheets of plans are adequate for the intermediate modeler.

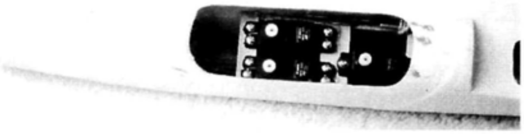
BUILDING

First decide which wing option and which of the three wing dihedral angles you want to build. I decided on an aileron-and-flap wing with a flat center section and removable, plug-in tips at a 5-degree dihedral angle. Build the center panel first. Construction begins with a conventional box spar constructed of two lengths of ⅛x¼-inch spruce stock with plywood shear webs (and balsa blocks) glued between them. You can add carbon fiber to the bottom of the compound spar, but it isn't really necessary because the spar built according to the instructions is very strong. To allow for a three-piece wing, glue brass joiner tubes into the tips of the spar. Glue the wing-cores to the front and back sides of the spar, and sheet them with 1/16-inch balsa (after the balsa sheets have been glued together). I had excellent results using Southern's Sorghum*.



A Dremel tool works well to cut out the radio hatch.

Now cut out the ailerons and the flaps, and cap them with the supplied 1/16-inch balsa. I covered the entire wing with Goldberg's* hot fluorescent pink Ultracote. AMP Graphics* supplied the Lumina decal. Their decals are top of the line; I have found that the corners



Note the ample room for the servos.

SPECIFICATIONS

Model name: Lumina
Manufacturer: Quality Fiberglass
Type: R/C sailplane
List price: $119
Wingspan: 74 in.
Wing area: 600 sq. in.
Wing loading: 9 to 10 oz./sq. ft.
Weight: 36 to 40 oz.
No. of channels req'd: 2 (rudder and elevator; aileron, flaps and mixing were also used in test)
Radio used: JR 347
Airfoil type: SD-7032
Wing construction: white foam-core; spruce/balsa spars; balsa-sheet covering with optional fiberglass reinforcement.

Comments: the kit includes a nicely made epoxy/glass fuselage and balsa-sheeted foam wing, rudder and one-piece, bolt-on stabilizer. Quality Fiberglass provides all the necessary hardware, and the blue-line plans facilitate construction. The wing is a three-piece, bolt-on design, and the nose cone slips on. Optional accessories used in this review include one servo per aileron for crow.

Hits
- Delivers competition-level flight performance.
- Can be built as a polyhedral floater or as a full-house aileron-and-flap ship.
- Highest-launching 2-meter sailplane I've seen.
- Aerodynamically efficient T-tail design.

Misses
- The advertised weight of 36 to 40 ounces is only realistic in the polyhedral version (expect a full-house ship to weigh 41 to 50 ounces).
- The ⅛x¼ spruce spar was warped; however, Quality Fiberglass replaced the entire wing panel.
- The fuselage cracked near the flaps. For no charge, Quality Fiberglass will add Kevlar or carbon-fiber reinforcement to any new kit at the buyer's request.

Sailplane

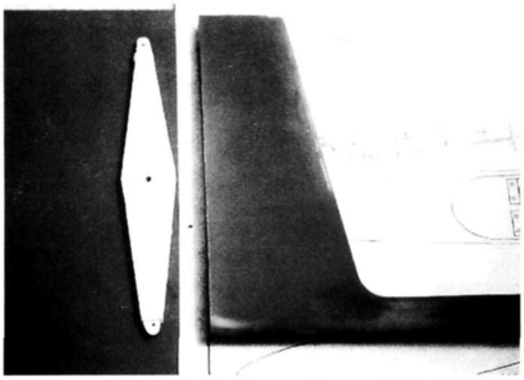
The author's wife, Lisa, shows off the Lumina.

don't peel up after flying for an entire season. After the wing has been finished, attach the aileron to it with Graupner* hinge tape. This works well; it holds the surface tightly against the wing yet is flexible.

FUSELAGE

As with most fiberglass parts, the fuselage had many pinholes; filling them was the most time-consuming part of construction. Before you do this, you must remove the mold-release agent by washing the fuselage with soapy water. Then spray the fuselage with Krylon primer to highlight the pinholes, and fill them with automotive glazing putty. After the putty has dried, sand it to remove the excess and most of the primer. I repeated these steps three times before I had found and filled all the pinholes.

Now glue in the wing hold-down block and the tow-hook plate, install the balsa elevator rocker arm, and cut an access hole in the front fuselage to install the servo rail. I



The rocker that fits in the fin provides a relatively tight, no-slop linkage between the servo and the elevator horn.

finished the fuselage with three coats of white Krylon paint.

STAB & RUDDER

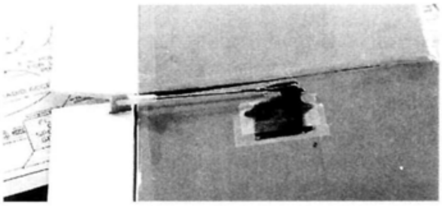
Building the stab and the rudder takes about half as long as building the wing. It's as simple as gluing the $\frac{1}{16}$-inch balsa sheeting to the cores and adding the leading edge to the stab and adding the balsa tips. Use a 5-32 bolt to hold the stab to the fuselage; reinforce the stab with light fiberglass cloth around this area. Then attach the rudder with Graupner hinge tape.

RADIO INSTALLATION

In this serious competition glider, I wanted to install an equally serious radio. I chose a JR* 347 computer radio with an FM 7-channel receiver. The receiver fit in the nose, but it was really cramped, so I opted for a smaller, 5-channel RCD* 535 micro receiver. With the smaller receiver, the "front office" was less crowded. I used Futaba* S-133 servos for rudder and elevator actuation. I used JR 341 servos for the ailerons and the Futaba 3002 servo (ball bearings and metal gears) for the flaps.

CONCLUSION

This product evaluation is based on my Lumina and a flying buddy's. Because he



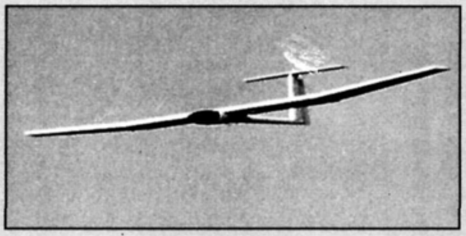
The aileron servos are snugly taped into bays cut into the foam wing.

built his model with one servo for both ailerons, it was 3 ounces lighter and seemed to float slightly better. Interestingly, after a few landings, both models had cracks in the fiberglass fuselage near the trailing edge of the wing. I repaired my model with a fiberglass patch that has held up well. My friend replaced his fuselage with a new one from Quality Fiberglass that has carbon fiber along its length. It's very durable. For no charge, at the buyer's request, Bob Sealy of Quality Fiberglass will add Kevlar or carbon-fiber reinforcement to any new kit. The Lumina has exceptional thermal capabilities, and it costs about \$20 to \$100 less than comparable sailplanes. I can see why Bob Sealy says, "...until we meet in the winners' circle, or somewhere close by."

Addresses are listed alphabetically in the Index of Manufacturers on page 137. ■

FLIGHT PERFORMANCE

To start, I set the Lumina's control throws as recommended in the plans: elevator—plus/minus $\frac{3}{8}$ inch; rudder—plus/minus $\frac{3}{4}$ inch; flaps—10 degrees up, 75 degrees down; aileron—$\frac{3}{4}$ inch up, $\frac{1}{4}$ inch down. After a couple of hand tosses to center the elevator, I was off to the local hill to do a little



slope soaring. With a flying weight of 47 ounces, the Lumina is no light-air machine; it seems to be a medium- to heavy-lift bird. Initial flights off a large high-start and a 12V winch led to average flight times of 4 to 10 minutes.

• Launch and landing

I had to experiment with various flap and elevator trim settings on launch. With too much flap, the Lumina popped off, and without enough flap, I wasn't satisfied with its angle or the altitude on launch. The setting that seemed to work best was with the flaps down $\frac{1}{4}$ inch and the tow-hook bent inward a little. Now, launches are nearly vertical with very little aileron or rudder input needed. In a strong wind, zooms off the top are great. On landing with the flaps down 75 degrees, the Lumina's speed is cut in half; this greatly increases landing accuracy. Total landing control was achieved with $\frac{1}{4}$ inch of crow (both ailerons up). I've noticed that some sailplanes lose lateral stability during crow, but the Lumina didn't exhibit this at all.

• Slow-speed performance

The Lumina will slow down to a floater-like speed, but the airfoil seems to be more efficient at medium speeds with the aid of 15 degrees of flaps. Banking during thermal turns are much more precise than they are with any of my polyhedral ships, with total control throughout. Stalls are straightforward with no surprises. Height loss during the stall series was very dependent on the amount of flaps used. With flaps set between 0 and 30 degrees, recoveries were in the 10-foot range. With flaps set between 30 and 75 degrees, the altitude loss was greater.

• High-speed performance

Placing the Lumina in a dive rapidly builds up speed with no adverse effects. With its low-drag T-tail, the Lumina is fast, though it's not as fast as it would be with the specialized speed airfoils, e.g., 7003, RG-15.

• Aerobatics

Most sailplanes aren't intended for aerobatics, but most of us can't resist. The Lumina will loop, roll, and fly inverted with ease, although at the expense of shorter flight times. Of course, on the days when the thermals are really popping, aerobatics are the icing on the cake.

SIMPLE PROGRAMMING

DAVID C. BARON

NEW IDEAS AND GREAT FUNCTIONS

WHEN WAS THE last time you reset the internal clock function of your radio? I'm referring to the count-up timer that starts and stops when you turn your radio on and off. I don't usually remember to reset it until I notice that there are more digits than there are hours and minutes in a month! Wouldn't it be valuable if inserting the charge jack into your transmitter automatically reset the clock? We already know that the digital voltage readout rises and falls with the capacity of our Ni-Cds, but the real value of this readout would be realized if we also knew how much time had elapsed between a full charge and the low-voltage warning. We'd know when the Ni-Cds weren't up to normal capacity and it was time to replace them.

To take this idea further, I'd like to see the duration of the last charge cycle shown on an intermediate screen. This could be used as part of a formula that would display information about current consumed the last time you went flying. For instance, it might show that you consumed 405mAh of your battery's capacity in the last discharge cycle (last flight). Since your radio uses a 600mAh battery pack, you know that about one third of the battery's capacity remains. If your low-voltage alarm goes off and you have used only this much capacity, it's time for new cells or a serious bout of cycling!

[Editor's note: with the continued advancements in computer radio displays—such as that on the Futaba 9-ZAPS—it's plausible that a display of real-time battery charge, discharge and capacity graphics could become a feature of the next generation of radios. Think of how handy it would be to punch up a screen and see a graph displaying information on how your batteries are functioning. Battery failures and related crashes could become a thing of the past.]*

The Ace MicroPro 8000 has features that set it apart from the rest of the computer radios on the market. Its auto-trim function offers a glimpse into the next generation of radios.

THE NEXT GENERATION

Do you use your timer to tell you when you're low on fuel and it's time to land? Many modelers do. I'm surprised that manufacturers haven't created an option that would slow the timer down as a function of throttle position—like the tachometer clock in most light planes. It could register engine hours so that if you spend your time puttering around the sky at low throttle, the clock would slow down, and the alarm wouldn't go off as soon.

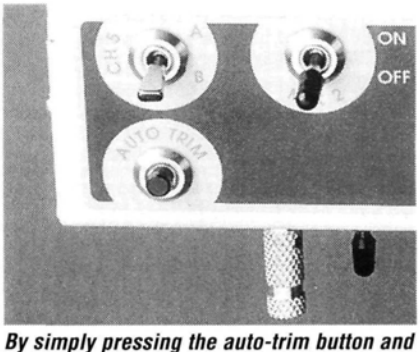
This sure would be a dandy idea for an electric duration glider. If you knew the total duration of the motor run at full throttle and set the timer to stop counting when the throttle was off, then the timer would warn you when you had only one climb left in your batteries.

GREAT FUNCTIONS THAT DESERVE TO BE NOTICED

The Ace R/C* MicroPro 8000 has "auto trim"—a feature that sets it apart from the rest. This function is really a glimpse into the next generation of radios. If your aircraft is out of trim, you simply hold down the auto-trim button while flying the model with whatever stick position (elevator, rudder and aileron) that makes it fly straight and level. The rate of trim change is adjustable on a separate screen. During this procedure (with the auto-trim button depressed), the stick deflection required to maintain level flight diminishes. Trimming is complete when the model flies level and the stick is centered. You can make fine adjustments by blipping the control stick while holding the trim button down. This gives you very fine trim increments.

I really like this feature a lot, and I foresee a day when manufacturers will eliminate traditional trim levers in favor of auto-trim functions. With the exception of throttle trim, let's give the rudder, elevator and aileron trim levers the heave-ho.

I'd keep the throttle trim because I like three positions for it and use each one on every flight: high trim for starting the engine, middle position for flying and low for engine kill. I wouldn't fly a plane that didn't have a positive engine kill.



By simply pressing the auto-trim button and flying your model straight and level, the amount of stick correction (rudder, elevator and aileron) required for straight flight diminishes until the model is perfectly trimmed and the control stick is centered.

So, to all the wise radio designers out there, let's lose the conventional trims (think of the money you'd save by reducing the parts count) and leap into the next generation of radios.

Some of you may argue that it's convenient to have an elevator trim for various flight speeds and conditions, but we're well into an era when elevator trim can be slaved to any other function, control, or servo motion. For example, I have a model that bleeds off speed more rapidly than I like, and if I cut the throttle back, it continues to slow down and eventually stalls in level flight. This makes for a very short and abrupt flare in any landing situation. I started using some down-elevator trim mixed with low throttle, and I like the result. I subsequently programmed in a -4 percent value of elevator trim and slaved this to the throttle-idle stick position. Now when I chop the throttle, the glide speed stays constant without the plane diving, and I get a much more natural flare.

So, to all the wise radio designers out there, let's lose the conventional trims (think of the money you'd save by reducing the parts count) and leap into the next generation of radios.

How about you, the users of these great radios—do you have any ideas or suggestions to make our computer radios better? Is there something—large or small—that you'd like to see added? Drop me a line, and I'll pass along your comments. Send your ideas to David C. Baron, c/o *Model Airplane News*, 251 Danbury Rd., Wilton, CT 06897.

**Addresses are listed alphabetically in the Index of Manufacturers on page 137.* ■

FIELD & BENCH REVIEW

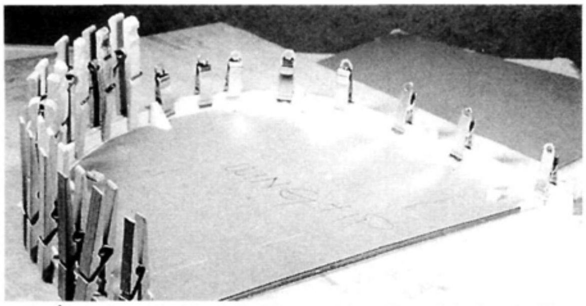
CLANCY AVIATION'S* Lazy Bee, which looks like the offspring of a Flying Flea and an Aeronca C3, will probably be very popular. From its pleasingly portly profile to its lovely, fat, elliptical-tip wing, it grabs everyone's attention. This airplane has the remarkable ability to look relaxed while waiting on the runway, and it's dashingly graceful when in flight.

The Lazy Bee was designed to be flown in a very small area when powered by a Cox* Texaco .049 engine. With that engine, it has even been successfully flown indoors! If the radio gear is moved a little farther aft to compensate for the additional weight in the nose, it will actually handle the power of a .15 to .20 engine. The MVVS .12 I use delivers more than enough power. There's no shortage of room in the cabin for

Ball Field Bomber

CLANCY AVIATION
Lazy Bee

by RANDY RANDOLPH



The ½-inch-wide stock that's used for the wing laminations needs a little additional help because it's so much wider than the cardboard form. Balsa right triangles pinned around the form keep the laminations vertical, and clothespins keep them tightly together.

moving the radio around; it can go almost as far aft as the leading edge of the stab and still be accessible!

The Lazy Bee is available in three versions:

• **Lazy Bee Deluxe**—an all-wood kit that comes with cut parts and most of what you need to finish the model. You supply covering material, hardware, wheels and glue.

• **Semi-Kit**—six sheets of balsa on which many of the parts' outlines are printed. This kit is for builders who want to furnish most of their own wood. There's a complete list of the extras you must supply.

• **Deluxe Semi-Kit**—has cut-out balsa parts and a list of what you need to complete the model.

Each version comes with a Clancy Aviation catalogue, full-size plans (three large pages), a well-illustrated construction manual, and templates for cutting the parts and the covering material to shape.

There's even a fourth way to build a Lazy Bee: you can buy the plans/instruction/template package. These people want you to build this airplane, so they give you a lot of options! Here, I review the Lazy Bee Deluxe.

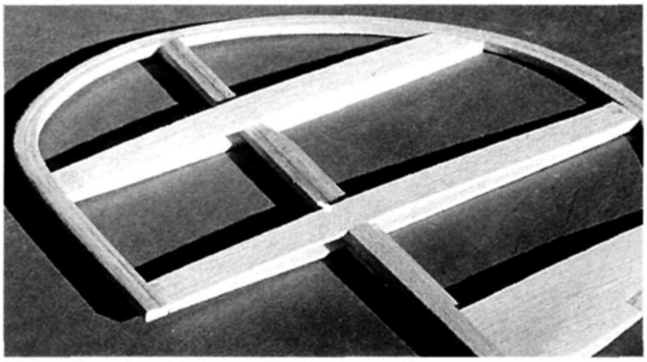
CONSTRUCTION

Neither the plans, which are blue-line drawings, nor the construction manual are super high-tech, but they're both very good, and if you follow them, you just can't miss. For example: the manual tells you how to make two tools: a balsa stripper with which, if you opt for one of the semi-kits, you can make your own strip wood and save even more money; and a tool for cutting out the circular holes that form the cabin windows. Such thoughtfulness is rarely found in construction manuals.

• **Laminations**. Following the manual step by step, first make the three forms around which the wingtip, the elevator and the rudder outlines will be laminated. Full-size templates are provided for these forms, and they're cut out of corrugated cardboard. Scraps of plastic film ironed around the forms' edges prevent the glue used in the lamination process from sticking to them. This is an idea worth remembering.

The most difficult part of the laminating was finding a pan long enough to soak the 30-inch balsa laminating strips. I settled for the bathtub! The forms are tacked to a building board covered with wax paper, and the soaked strips are coated with white glue and pulled around the forms. Pins at the ends (and a few in between) hold the laminations in place.

The rudder curve looked as though it would be the most difficult one to make, so I made it first. It turned out to be a piece of cake, as did the others. Because the wingtip outlines are made of ½-inch-wide stock, I added a few balsa right angles to the edges of the cardboard template just to make sure that the laminations would stay vertical.



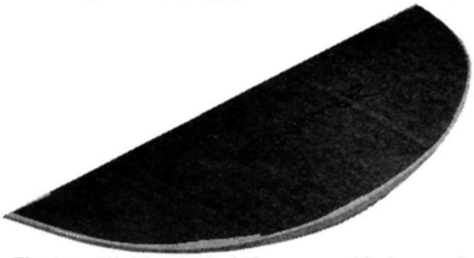
Although laminating looks difficult, it's really very easy and quick to do. The full flying rudder looked as if it would be the most difficult to laminate, but it was a snap! The tail-wheel bracket is added as the rudder is assembled.

Before removing them from the forms, give the laminations a full day to dry completely. The toughest part was sanding them when they were finished. If shortage of time is a factor (and it shouldn't be!), a razor plane is a great help when shaping the wingtips.

• **Wing**. Build the wing in the traditional way; it has only seven ribs, so you can build it in a hurry. The leading and trailing edges are braced at the dihedral breaks with plywood, and the overlapped spars provide the beef. All this is done while the wing is still pinned to the building board. When the wing is lifted off the board and the bottom spars and the shear webs are added, it's practically finished; all it needs now is a little additional sanding.

The rudder and elevator outlines have already been finished and sanded, and the tail surfaces practically build themselves. The manual does a good job of describing the construction of the full rudder, but the rudder does go together a little differently from the standard rudder and fin we're used to.

• **Fuselage.** Assemble the fuselage sides over the plan—as usual! Assembly is typical, up to a point, and that point is the forward part of the fuselage; it isn't all that difficult—just different. Before adding the forward part, including the landing gear and the firewall,



The beautiful laminated tips are molded around corrugated-cardboard forms. To prevent the white glue used to make the laminations from sticking to the forms, their edges are covered with scraps of iron-on plastic covering material.

SPEC-IFICATIONS

Model name: Lazy Bee
Type: Basic trainer
Manufacturer: Clancy Aviation
List price: Deluxe Full Wood Kit—$49
Wingspan: 40 in.
Wing area: 520 sq. in.
Weight: 28 oz.
Length: 26 in.
Wing loading: 7.75 oz./sq. ft.
Wing chord: 14 in.
Wing thickness: 1.75 in.
Stab area: 137 sq. in.
Rudder/fin area: 50 sq. in.
Airfoil type: flat-bottom
Washout built into wing?: no
Rec. engine: Cox Texaco .049 (can be flown with a .15 to .20)
Engine used: .12 MVVS
Prop used: 8x4
No. of channels req'd: 3
Radio used: Futaba*
Wing construction: balsa w/laminated wingtips
Kit construction: balsa and plywood

Features: this all-wood kit involves making laminations, but the procedure is well-described in the instructions, and it's really easy to do. The kit is available in three versions, from Deluxe to Semi-Kit (for those who prefer to choose most of the wood themselves). As a fourth option, you may buy just the plans/instruction/template package. Clancy Aviation really want you to make this plane, so they offer a lot of options.

Hits
• Parts pre-cut accurately and cleanly
• Three plan sheets with templates for every part.
• Instruction manual with lots of extra hints.
• Good wood selection for specific areas.

Misses
• Some thin plywood parts aren't pre-cut.
• Airplane is a little difficult to hold while you start the engine.

CHECK OUT THIS CZECH

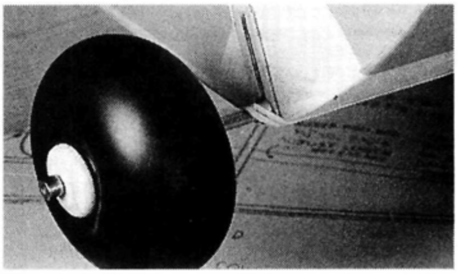
The MVVS .12 R/C glow engine has a displacement of .12 cubic inches, it weighs 4.9 ounces and produces .22hp at 15,500rpm. When the engine has been properly broken in, the throttle allows a smooth transition from full power to a 3,000rpm idle. Break-in is important because these engines are set up with rather close tolerances, and an hour on the bench at various needle settings should be considered a minimum.

Note the screw-in prop shaft. It has a standard thread, so a bent or broken shaft can easily be replaced locally. The MVVS .12 is also available as a diesel with a throttle and a muffler.

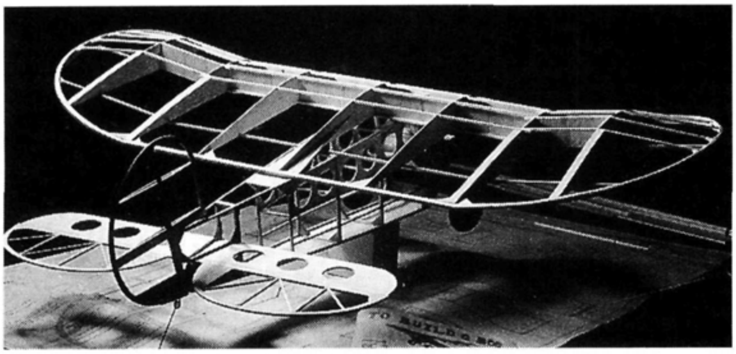
MVVS has been in the model airplane engine manufacturing business in Czechoslovakia since 1952. In the intervening years, their engines have won many world championships. Owing to marketing difficulties, however, they aren't very well-known here. Now, with the free market, this line of high-quality engines has become available to American modelers.

complete the fuselage from the leading edge of the wing to the tail post. It looks unusual, but if you follow the manual, you'll have a fuselage that's straight and true.

- **Engine mount.** If you plan to use an engine larger than a .049 to a .051, the manual tells you how to modify the engine mount to make it easier to get fuel and throttle lines to the engine with the firewall provided. But to mount a .15 or .20 engine, you might be happier with a new firewall that's slightly thicker than the one supplied. You'll also have to trim the chin cowl a little to clear a bigger engine mount.
- **Landing gear.** The landing gear is unique and effective. The straight axle slips into a slot that goes through the fuselage and is held in place by rubber bands that are looped around the bottom of the fuselage. In effect, it's a shock-absorbing gear; the rubber bands act as bungee cords that allow the axle to slide up in its slot on very hard landings. In this way, the gear compensates for one-wheel landings and survives some that would otherwise call for repairs. With the big Trexler balloon wheels, this is the softest gear you can imagine.



The straight axle goes all the way through the fuselage and rides in a plywood box. Rubber bands around the bottom of the fuselage act as bungee cords for a true shock-absorbing landing gear. With big balloon wheels, landings are unbelievably soft and smooth.



The bare bones Lazy Bee shows off its graceful wing, which has only seven ribs for all of its 520 square inches of area. Despite its lightness, this airplane is rugged.

COVERING

The manufacturer suggests that you cover the Lazy Bee with Litespan, and I just followed the material's instructions. If you haven't yet used this light plastic covering, you really should give it a try. It's waterproof and impervious to diesel and glow fuels, so it's ideal for any light model. When used with Balsaloc adhesive, it's easy to apply and shrink. When it's finished, it looks like doped tissue, and it's almost as light! The covered wing weighed only 4½ ounces—with an area of 520 square inches! And don't let its lightness fool you; this Litespan is tough stuff.

The plan sheets include templates that greatly simplify cutting the covering material to fit all the surfaces. There are also templates for the trim, and the manual goes into some detail about how to pre-glue the Litespan to make the trim a lot easier to apply. Because it's so easy to duplicate the color scheme of the original and it looks so good on the airplane, it's difficult to do otherwise. Covered with Litespan, powered by the little MVVS .12 and with a 3-channel radio, the finished airplane weighed 28 ounces! That means a wing loading of less than 8 ounces per square foot; no wonder it's such a peach of a flier. By the way, like the Lazy Bee, Litespan, Balsaloc, Trexler balloon wheels and the MVVS line of engines are all available from Clancy Aviation.

**Addresses are listed alphabetically in the Index of Manufacturers on page 137.* ■

FLIGHT PERFORMANCE

What can I say? This is one sweet flying airplane. The MVVS .12 provides more than enough power, and that's to be expected, because the Lazy Bee was designed to fly with a Texaco .049. This airplane is everything it's supposed to be—fun, gentle and forgiving enough for the most relaxed type of flying. The Lazy Bee would make a good basic trainer, but would probably spoil the student!

• Takeoff and landing
On grass, the takeoff roll is about 7 feet, and on a smooth runway, you're never quite sure whether the Bee is flying or just rolling smoothly on that forgiving gear; if there's a breeze, it's probably flying. Landings are unbelievable. That nice soft gear and slow landing speed make the transition from flying to rolling very difficult to notice, even on a rough field. Anyone who has trouble with bouncy landings should fly a Lazy Bee just to give his ego a boost.

• High-speed performance
Definitely does *not* apply!!

• Low-speed performance
Here's where the Lazy Bee is a super specialist! With the control throws and balance point set as suggested in the instructions, the Bee is very gentle and forgiving. If you're looking for a model to travel with—one that can take advantage of small areas with trees around them—the Lazy Bee is the best choice. It's also great for the RV set.

• Aerobatics
With the control throws increased only slightly, the Bee will do all the tricks that you'd expect from a 3-channel rudder airplane. It isn't very happy with inverted flight, even though it can be made to stay there for a while; but what the heck! It looks so much better right-side-up; that's the way it should fly.

HOW TO

Trickle-Charging 12-Volt Batteries

by ROBERT S. HOFF

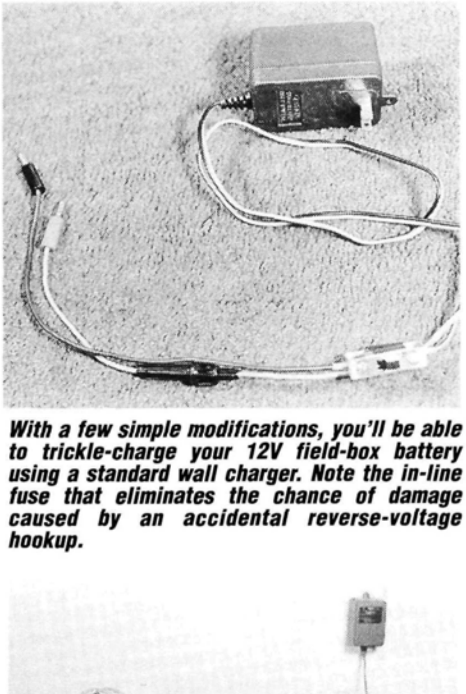
Enhance the life of your field-box battery with this simple modification.

MOST MODELERS I know have a field box, and most of the field boxes contain a 12V lead-acid battery to provide power for the power panel. These batteries may be gel-cells, sealed batteries or the less expensive and more common wet-cell type to which water must be added from time to time.

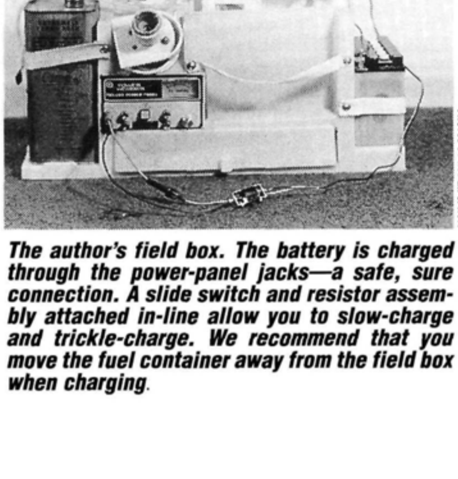
Gel-cells and sealed batteries have the advantage that they require no maintenance and can be shipped by UPS. Unsealed wet-cell batteries can be shipped, but the electrolyte is not included and must be procured locally.

Even though lead-acid batteries are in widespread use, one seldom sees anything in the R/C literature about their care and charging. One of the most important facts about lead-acid batteries is that they are damaged by being deeply discharged and allowed to remain in that condition. The longest life is obtained from these batteries by keeping them fully charged. Hence, trickle-charging is important for more reasons than just having them ready to use. Despite the importance of trickle-charging, I can't remember seeing a 12V trickle-charger advertised, although at least two chargers, the Ace R/C* CVC and the Licto Systems* 12V Automatic Charger/Monitor, change their charging rate to trickle when the battery approaches full charge.

Low-cost chargers for lead-acid batteries are usually the constant-voltage type. Charging current with a constant-voltage charger starts high and drops off exponentially as the battery reaches full charge, although the rate at full charge is still too high for trickle-charging. For batteries with a capacity in the 5A- to 8A-hour range used by most modelers, the initial charging current will be in the range of 400mA to 700mA, and most of the low-cost wall chargers used by modelers have a current rating in this range. By contrast, Ni-Cd battery chargers are usually near-constant-current sources, such as the wall chargers furnished with most radios.



With a few simple modifications, you'll be able to trickle-charge your 12V field-box battery using a standard wall charger. Note the in-line fuse that eliminates the chance of damage caused by an accidental reverse-voltage hookup.



PHOTOS BY ROBERT S. HOFF

The author's field box. The battery is charged through the power-panel jacks—a safe, sure connection. A slide switch and resistor assembly attached in-line allow you to slow-charge and trickle-charge. We recommend that you move the fuel container away from the field box when charging.

It's easy to add a trickle-charge capability to the common 12V wall charger and, at the same time, make modifications that will prevent the charger from being damaged if the terminals accidentally touch, or if they are connected to the wrong terminals of the battery.

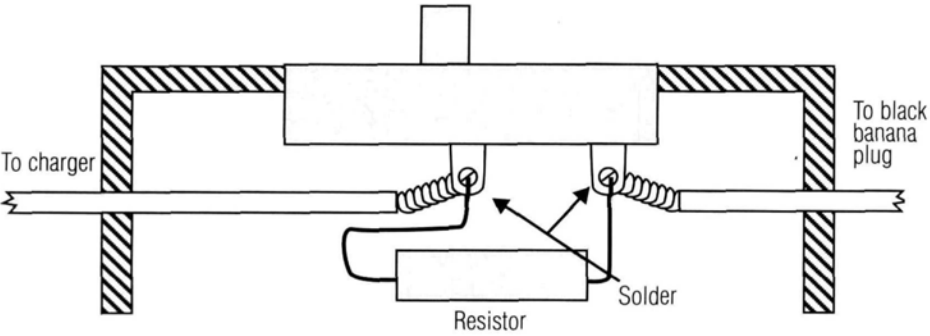
Personal experience has shown that shorting the terminals together will destroy one or more of the rectifiers in the charger. Replacing them is usually difficult, because the charger cases have no provisions for disassembly. Connecting the charger terminals to the wrong battery terminals will destroy the transformer by melting the wire in the transformer primary winding. This is not reparable.

My modifications minimize the risk of damage to the charger caused by shorting the charger terminals or connecting them to the wrong battery terminals. This is accomplished by putting a fuse in series with one of the charge leads. The fuse holder (Radio Shack* part no. 270-1281) is used with a 3/4A, 1/4x1 1/4-inch, fast-acting fuse (Radio Shack part no. 270-1272, package of three). I have reduced the likelihood of shorting the charger terminal (by letting the leads touch) by shortening one lead so the terminals are staggered.

Provisions for trickle-charging at a rate of .001 of the battery's capacity (6mA for a 6Ah-capacity battery) have been made by putting a slide switch (Radio Shack part no. 275-401, package of two) in the charging line with a

FIGURE 1

DETAILS OF THE SWITCH/RESISTOR ASSEMBLY



1. Build a box of 1⁄16-inch plywood with no bottom and with holes in each end for the leads that will be connected to the switch. I mounted mine in a homemade aluminum frame holder (the cover was removed for the photos), but you'll find it easier to mount it in a small plywood box.

2. Bend the resistor's axial leads as shown, pass the leads through the holes in the switch terminals, and bend them back on themselves. Clip off the excess.

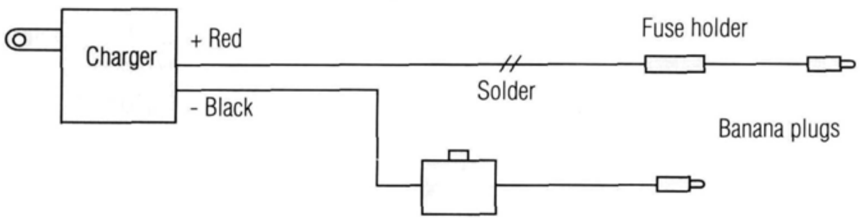
3. Mount the switch/resistor assembly in the top of the box as shown.

4. If the charger leads have been molded together, carefully separate them for 12 inches from the original ends, and cut 10 inches off the black lead. Remove ⅜ inch of insulation from each length of black wire, and solder in the switch/resistor assembly as shown in the illustration.

5. After passing the lead through the hole in the switch box, solder the free end of the black charger lead and one of the resistor leads to one switch terminal.

FIGURE 2

12V WALL CHARGER MODIFICATIONS



6. Take both battery clips off the ends of the charger leads, cut off and discard 6 inches of the red (+) lead, and remove ⅜ inch of insulation from the end of each lead.

7. Attach the black banana plug to the black (–) charger lead.

8. Solder one fuse-holder lead to the red (+) charger lead. Insulate the joint with electrical tape or shrink tubing.

9. Attach the red banana plug to the other lead of the fuse holder, and install a fuse in the holder.

resistor across it. This trickle rate is recommended in the Gates* Engineering Handbook. I found that a 470-ohm, ½W resistor (Radio Shack part no. 271-019, package of two) did the job for me. Depending on the open-circuit voltage of your charger, you might have to reduce the resistor value to 390 ohms or increase it to 560 ohms to get the recommended trickle current. If you don't have the capability to measure current, stick with 470 ohms.

Another change I made to my charger for convenience was to replace the spring clips on the end of the charging leads with banana plugs (Radio Shack part no. 274-721, set of two). The red one goes on the positive lead, usually red, and the black one on the negative lead, usually black. These plugs allow you to connect the charger to the battery by plugging them into the corresponding starter terminals (plus to plus and minus to minus) on the power panel, rather than directly into the battery terminals. The starter terminals are connected to the battery that's inside the power panel. You can minimize the risk of blowing the fuse by remembering to plug the banana plugs into the panel before plugging the charger into the wall.

OPERATING THE "NEW" CHARGER

Set the switch for full-rate charging (closed), and charge the battery till it reaches full charge. Then open the switch to trickle-charge.

The switch is not marked to show which position of the slide opens the circuit and which closes it. You can determine this using a continuity tester. If you don't have one, closed is the position that causes the pilot light in the charger to glow normally. Open is the position that causes the light to go out or to dim. I marked my switch positions "T" for trickle and "C" for charge.

You can estimate charge condition using a hydrometer or by observing when the battery voltage under charge conditions reaches about 14.2 volts. If you don't have a voltmeter, charge overnight and then switch to trickle. Don't forget, a wet battery needs water occasionally, even when in trickle-charge.

As an aside, the slide switch in the photo is a single-pole, double-throw (SPDT) type, not the single-pole, single-throw (SPST) type shown in the diagram (and recommended). I happened to have a SPDT unit on hand and adapted it. Schematics of the circuit before and after modification and details of the switch/resistor assembly are shown in Figure 1.

*Addresses are listed alphabetically in the Index of Manufacturers on page 137. ■

MODEL AIRPLANE NEWS MAGAZINE CONSTRUCTION

The author checks hover trim (see text).

PART 2

the Vertigo

Design insights and flight testing

by TOM HUNT

VTOL R/C SPORT MODEL

LAST MONTH, I introduced you to a unique model I designed, built and flew that can take off and land like a helicopter, but can fly like a fixed-wing aircraft. These types of vehicles are called VTOL (vertical takeoff and landing) aircraft. The model was constructed and assembled with off-the-shelf, commercially available items.

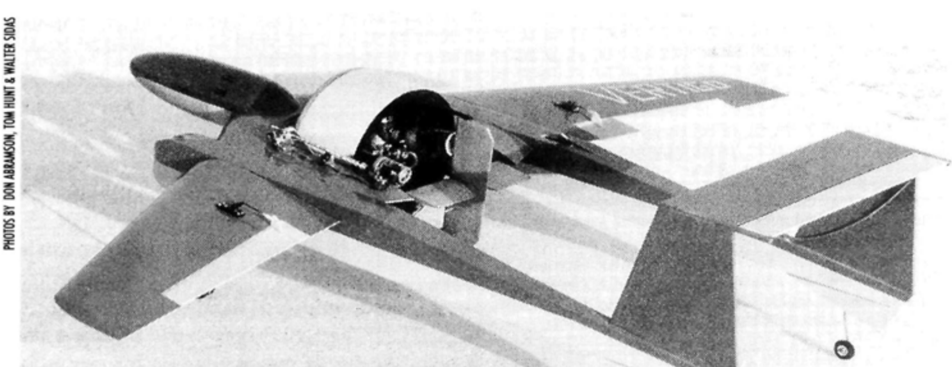
The subject of this article is the third model VTOL aircraft to successfully complete an outbound (from hover to fixed-wing flight) and inbound (from fixed-wing flight to hover) "transition." The first model—the one that inspired me to proceed with this project—was a twin-ducted-fan model that I worked on for my employer (Grumman Aerospace). The model, the subject of an article by John Gorham in the October '93 issue of *Model Airplane News,* made its historic, flight-mode transitions in January '93. The project was funded by Grumman as research into the viability of using a VTOL drone for AEW work (airborne early warning). The model was large (20 pounds), had a high level of complexity and was rather expensive—too expensive to convert the technology into a model that the slightly-above-average modeler could build.

In stepped the Vertigo: a small, lightweight and considerably less expensive outgrowth of the twin-fan model. This second model, i.e., the first Vertigo model—an early prototype of the aircraft featured in this two-part series—had a nasty tendency to loop during inbound transition. Because the needed changes would necessitate major alteration of the vehicle, a second prototype was built.

Creating an R/C model that can be precisely controlled during hover and transition is not an easy task. Using a Grumman-developed vane-control system for hover and transition made the project feasible (see Figure 5). These vanes create forces and moments to control the three rotational axes of the vehicle (pitch, roll and yaw). Conventional "aero" devices (ailerons and elevator, rudders optional) control the model in forward flight. A lead screw, driven by an electric motor, provides nacelle tilt (rotation of the prop-fan unit to provide vertical or horizontal thrust).

The model weighs approximately 9 pounds fueled, and the prop fan delivers over 10 pounds of thrust on an O.S.* .46 VRDF ducted-fan engine. The model carries 12 ounces of fuel, which is more than sufficient to make 4- to 5-minute flights.

PHOTOS BY DON ABRAMSON, TOM HUNT & WALTER SIDAS



The Vertigo sits poised on the ice, awaiting an early test flight.

Flight testing and trimming

Before you take your hard work out to the field for the first time to blow the dirt off the runway, make sure that the CG is precisely on the main spar tube. The model must also balance left to right. Vane deflections for pitch and roll (on high rates) should be + or – 20 degrees (3/4 inch at the trailing edge). Differential-pitch vane control (yaw) should be about 30 degrees (1 1/8 inches at the trailing edge).

I won't mislead you here. Even with this high deflection on the differential-pitch vane, yaw control is weak, but acceptable. On calm days, you can point the nose wherever you like with the rudder stick. But even in light breezes, the model tends to "weathervane" into the wind. Yaw control at this point is very sluggish. The good news is that you want to transition outbound into the wind anyway, and the model will stay pointed there without your help! The same thing is true for the inbound transition. If you start the transition not quite off into the wind, don't worry; as soon as the transition is complete, you will be!

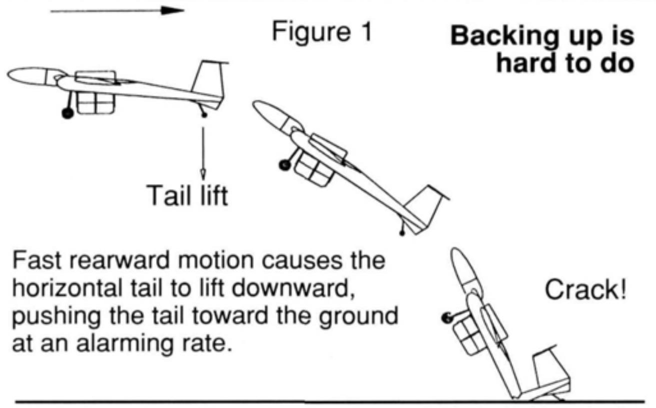


Figure 1 **Backing up is hard to do**

Fast rearward motion causes the horizontal tail to lift downward, pushing the tail toward the ground at an alarming rate.

First, attempt some low-altitude hover flights (no more than 4 to 5 feet off the ground). Takeoff from the ground is preferable, but if the gyros or vanes need to be adjusted (significantly), you may not get up high enough to get out of ground effect before the model becomes erratic. Ground effect (fan-flow re-ingestion) can mislead you into thinking you need less gyro rate or vane up-trim when, in fact, you may need the opposite in both cases. Instead, have a pair of friends (what do you mean, you only have one!) each hold a wingtip in an open palm (Figure 2)—keeping their other hands ready for retrieval—about 4 feet off the ground. Try to trim the model at about 90 percent power. Your helpers should be able to tell you which way it's tipping (left or right, up or down). Once the model has been trimmed for level hover, attempt to fly out of their hands. If the gyros are not fast enough, you will immediately notice a severe wobble in the axis that needs more gain.

Have the helpers snatch the model out of the sky and put it on the ground. If the gain is already "maxed out," move the pushrod on the vane in one more hole. To take care of the increased movement you will now get because of the change in horn position, turn down the "dual rate" on your programmable transmitter to about 80 percent. Turn "on" the dual rate (or rates) on the wobbly channel(s). The gyros don't know that the dual-rate switch is on, so you have mechanically increased the gain at the vane.

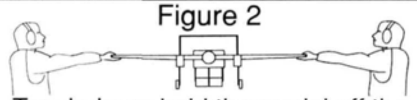
Repeat the hover tests with your helpers, assuming that the rates and the gains are now close. Pick the model up by yourself at high throttle from one wingtip or the horizontal tail. Hold the model lightly in your fingertips as you find the point at which thrust equals weight. You can do the final trimming now. It should be easy for you to sense a pitch, yaw, or roll trim that may still be necessary.

If yaw trim is necessary, bend the aluminum tabs on the fan stators in the appropriate direction. It should take only about an 1/8- to 3/16-inch deflection at the trailing edge to trim out the torque of the engine. If either the pitch or roll vane needs excessive trimming, add weight or move equipment around until the trim is slight or not needed. Excessive vane deflection for trimming a level hover robs the engine of thrust! Measure and record any trimmed vane deflection from neutral. Move the trim lever on the transmitter back to center, and mechanically change the trim on the vane as necessary (screw or unscrew the clevis). Be sure that the aileron and elevator return to neutral.

TRIMMING FOR HORIZONTAL FLIGHT

Let's assume that you now have a stable, hovering, fixed-wing airplane. The next step is to trim the model for horizontal flight. With the nacelle positioned horizontally, take the model off conventionally. It will probably need only about 20 to 30 feet of runway. (Remember, even in this position, the model has about a 1:1 thrust-to-weight ratio.) Fly and trim the model as required. Land the model normally, but keep the speed high as this model has a higher than normal wing loading. If any aileron or elevator trim is necessary, correct it mechanically at the horn or servo to allow the trim lever on the transmitter to once again return to neutral.

Figure 2

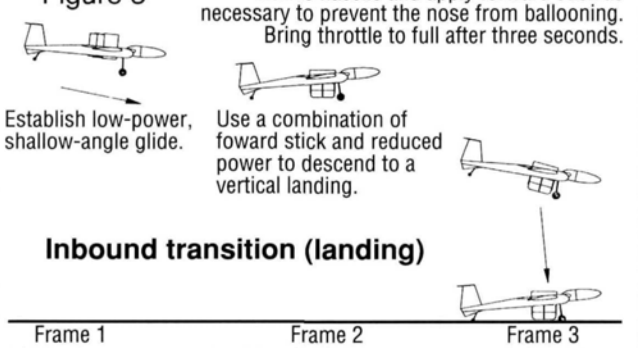


Two helpers hold the model off the ground with the wingtips lying in their palms. (Note ear protection.)

First hover attempts

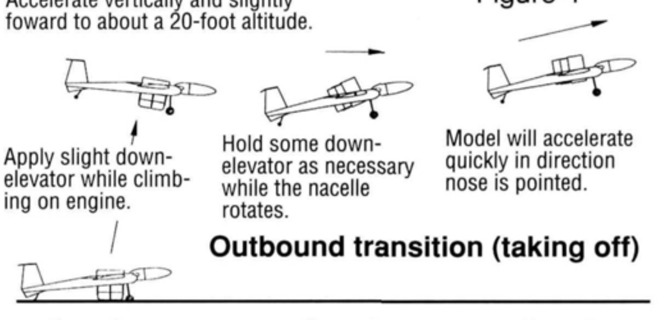
At this point, there is nothing to do but put together the hover and the horizontal in one flight!

Figure 3



Inbound transition (landing)

Figure 4



Outbound transition (taking off)

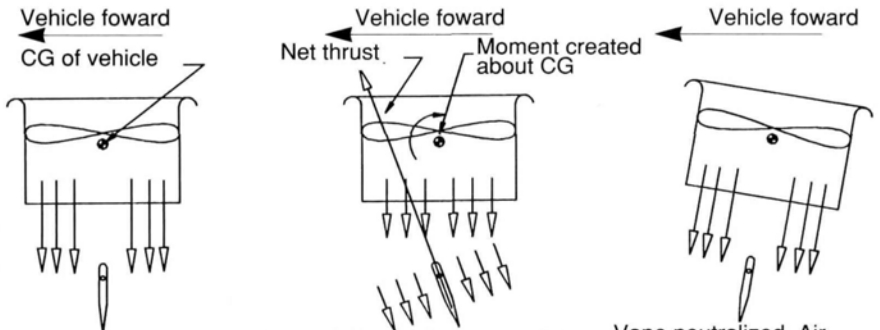
Prop Fan vs. Ducted Fan

Ducted-fan technology has come a long way in the last decade or so—more thrust, more horsepower and higher exit velocities (faster models). All these things are welcome for CTOL (conventional takeoff and landing) aircraft. But if you want to produce a lot of thrust statically, i.e., VTOL-type aircraft, nothing beats *diameter!* Helicopter models (and full-scale choppers) benefit most from increased diameter. Relatively small-displacement engines, properly geared, turn large rotors at slow speeds and produce enormous amounts of thrust for a given powerplant weight. Most of us have seen 6-pound helicopters accelerate vertically like an Estes rocket on a .40-size engine! The helicopter, however, is hindered by poor forward speed. Recently, Boeing and Bell designed and built a vehicle (the V-22 Osprey) with two large props that rotate from vertical to horizontal. This gives the aircraft a large payload capability, but extends the horizontal speed range well beyond that of even the fastest helicopter.

The full-scale and sub-scale aircraft designer's most important consideration when designing a VTOL model is *pounds of thrust per pounds of weight of the propulsion system.* A typical model helicopter (.40-size class) propulsion system (motor and drive train) weighs about 1.5 pounds. It is capable of creating about 12 pounds of static thrust, giving it a thrust-to-weight ratio of 12:1.5 or 8:1 while consuming about 1.0 to 1.25hp. Un-piped ducted fans in the 5- to 6-inch class generate 10 pounds of thrust while absorbing about 3.5hp (and spinning around 20,000rpm) for a propulsion-unit weight of about 3 pounds, which equates to about a 3.3:1 thrust-to-weight ratio.

Then there are "prop fans." A prop fan is nothing more than a conventional two- or three-blade propeller spinning inside a duct or prop shroud. Prop fans are usually considerably larger than ducted fans. The larger diameter allows you to use a lower-horsepower engine and have a corresponding lower propulsion-system weight than with ducted fans.

Figure 5 **Forces and moments**
Grumman patented hover and transition flight controls



No vane deflection. Air exits straight. Thrust acts through CG. Vehicle in hover.

Vane deflected (momentarily). Vane turns air. Net thrust now acts slightly below and forward of CG, causing nose-up moment.

Vane neutralized. Air exits straight. Thrust acts through CG. Inclination of duct causes rearward motion.

Part 1 discussed the design and construction of the model. In this concluding installment, I'll discuss parts of this project that didn't work, those that worked OK, but could have been done better, and things that worked better than I had expected. A discussion will follow of just how to go about flight testing the vehicle to improve chances of success and, finally, where this type of vehicle could go in the future (future concepts and capabilities).

PROBLEMS SOLVED AND THINGS TO AVOID

Some aspects of this and previous designs that failed miserably—and the solutions to those problems—are worth mentioning here so that the modeler who attempts a

Ironing out the Bugs in the Prototype

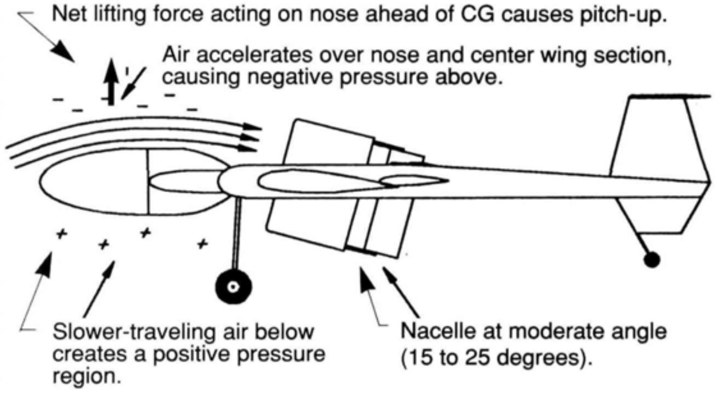
AUGUST 1, 1993...early morning fog at the flying field. Confirmed the model and pilot's ability to hover while fog was clearing. When the sky finally cleared, I cleared the butterflies out of my stomach and took the model up to about a 20-foot altitude in a hover to begin the outbound transition. I threw the nacelle-tilt switch into horizontal. The model began to accelerate quite nicely, but I noticed that the nose had begun to rise. I held quite a bit of forward stick to prevent the nose from rising any further. A second later, the fan was horizontal and the model was accelerating at an impressive rate.

THE SYMPTOM

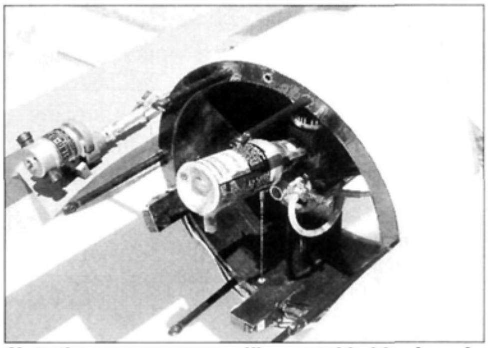
The excess forward stick at this point caused a mild dive, but this was corrected before the model came near the ground. I did it!—well, half of it, anyway! I flew a couple of laps around the field to calm myself down. I set up on the third lap, at low throttle, down the runway center line, about 150 feet up and threw the nacelle-tilt switch to vertical as it came over the threshold. The model instantly pitched up to vertical! I could not stop the ensuing loop even with full down-elevator, so I stopped trying.

About then, I decided to

Why the prototype ballooned



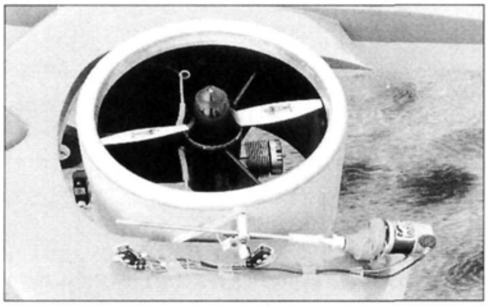
A 9- to 10-inch prop fan with a .46 engine (un-piped) spinning at 18,000rpm can weigh in at about 1.5 pounds. While consuming about 1.5hp, it can generate in excess of 10 pounds of thrust! That's a thrust-to-weight ratio of nearly 6.7:1! This superior thrust-to-weight ratio comes to us with lower-cost, more easily replaced props and a fuel consumption that's no higher than those of its ducted-fan relatives. The only drawback is its larger size—not terribly practical for scale applications, but wonderful for designing model VTOL aircraft.



Note the mousse-can muffler, provided by Jerry L. Smith.

DESIGN CHALLENGE

This discussion has been limited to unpiped engines, mainly because the installation of even the shortest tuned pipes in VTOL models causes an installation problem (they hit the ground when the nacelle is vertical). There is another problem associated with using a tuned pipe. Tuned pipes are either "on" or "off." When the engine is not "on the pipe," the model stays on the ground. When the throttle is advanced to the point at which the pipe turns "on," the increase in rpm (and thrust) is sudden and dramatic, launching the model into the air. Without collective pitch, as in a helicopter, hover is difficult, if not impossible. The model either ascends "on the pipe" or descends "off the pipe."



The prop fan is an ideal propulsion system for a VTOL model.

In my Vertigo, I used a modified competition fun-fly muffler that was designed by Jerry L. Smith. *[Editor's note: these are made out of mousse cans; see his article in the March '94 "Model Airplane News" for general construction tips on mousse-can mufflers and his follow-up report on mousse-can-muffler performance in "Airwaves" on page 8 of the June '94 issue.]* If you can dream up a better muffler solution, let me and the editors know by writing to me care of *Model Airplane News*, 251 Danbury Rd., Wilton, CT 06897.

For those of you who are curious to equate diameter, thrust and b.hp, the equation goes something like this: T = 13.13 (Ef x De x b.hp) raised to the $\frac{2}{3}$ power, where:

T = thrust available;

Ef = efficiency of the engine/prop or fan (.65 is a conservative number based on experimental data);

De = exit diameter of the duct in feet;

b.hp = brake horsepower available from the motor. (Manufacturers usually furnish this information based on rpm you will *not* operate at, so it's nice to have a complete curve of b.hp versus rpm.)

Now you have the basics, and the rest is up to you!

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project like this will not repeat them.

• **Gyros.** Gyros, which are *absolutely* necessary to stabilize the model during hover and transition, must be high-quality, extremely sensitive and very high-gain (output to servo). In my experience (and I've tested a variety of Airtronics*, JR* and Futaba* mechanical gyros), the only ones that have sufficient sensitivity and gain for this application are Futaba G-154s. If you try others and find that they don't work, don't blame me! A G-154 was originally installed on the roll axis in the model.

I did try two JR 150 gyros on the model's pitch axis, but the gains were "maxed out," i.e., the gyros were marginally adequate in this application. As

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come to full power and expedite the loop. By the time the model was upright (at the bottom of the loop), it was in a stable hover—no fault of my own! I had actually *gained* altitude during this unexpected maneuver. I flew the model down to my landing pad from about 200 feet. As soon as the model was safely down, I collapsed to the ground, mentally exhausted, but overjoyed that no matter how strange that first flight was, I was going home with an intact airplane!

I couldn't very well publish an article on this model until I had solved this looping inbound-transition problem.

THE PLOT THICKENS

Two days later, I gave a demonstration at Grumman to a group of engineers and program managers. Although determined to correct the looping problem through flying technique, I failed three times that day. The first two inbound transitions began as a climbing, right-hand, 360-degree turn and ended in an altitude-gaining hover. The Grumman engineers were amazed! The third inbound ended in a loop like the very first one, but at least this time, I knew what to expect.

Many expert opinions were ventured that morning. The most common one was that the horizontal tail (being immersed in the fan flow) was the culprit. The theory was that the horizontal tail was "seeing" an increased negative angle of attack (downwash) from the first few degrees of fan rotation. This would normally cause a pitch-up. The horizontal tail was moved from behind the fan to the top of the vertical tail that night. On August 9, I was back out on the runway to try again. No change! In fact, the pitch-up on the "outbound" got worse. Boy, was there some head scratching going on that morning!

THE CURE

The head of "Propulsion" at Grumman suggested that the pitch-up was probably being caused by the high-velocity (low-pressure) air coming over the top of the nose pod and forward wing into the rotating nacelle. Very little, if any, air was coming into the bottom of the fan to offset this velocity. The lower pressure above the nose and the higher pressure below would create a significant force ahead of the CG, causing a pitch-up during the first 45 degrees of nacelle rotation (from horizontal to vertical) and the last 45 degrees (from vertical to horizontal). Many schemes were suggested to combat this force; all of them required major surgery to the model.

A simpler solution was suggested: speed up the nacelle-tilt rotation. If the nacelle-tilt rate was fast enough, forward stick might be able to combat the pitch-up. That was tried next. It helped considerably, but during some inbound attempts, the model still had a tendency to loop. A new model—featured in this article—with changes to the nose pod and center wing section, along with an auxiliary fixed nacelle vane, reduced the pitch-up significantly.

I mentioned in Part 1, I recommend Sundance Model Products* SSG-1 solid-state gyros for ease of setup, low weight and low current drain. All the transition flights of the feature model were accomplished with these gyros.

• **Diode.** Diodes are in the circuit to actuate the electric motor (that drives the tilt-nacelle lead-screw) at the proper speed. It takes about 5 amps to lift the nacelle from vertical to horizontal. Do not use any diode with less than a 6A rating on this leg of the circuit, or do as I did and put two 3A diodes in parallel. Too small a diode current-capacity rating will result in an overheated diode and cause it to fail. A single 3A diode is fine for the leg that drives the nacelle from horizontal to vertical.

• **Glow plug.** Do not use any glow plugs not intended for ducted-fan use. You will blow a plug every flight if you try to use standard plugs. You also risk losing the engine during inbound transition (an airplane falling straight down from 200 feet like a non-auto-rotating chopper is not a pretty sight!).

• **Servos.** High-quality micro/mini-servos must be used for vane control. Any electrical or mechanical slop in the servos will cause the gyros to become less effective or ineffective. The gyros will sense the "hysteresis" in the vane control and attempt to correct for it, causing the model to wobble in any affected axis. Do not expect $10 servos to do the job! Buy yourself some Futaba S133s, Tower* TS-11s mini-servos, or Hitec HS-205BB microservos, or any name-brand, high-quality servo. Stay away from metal-gear servos, though (some come with, some without, metal gears). The mechanical vibration of the nacelle causes this type of servo to emit an electric "noise" that feeds back to all the servos and causes an unwanted "dither."

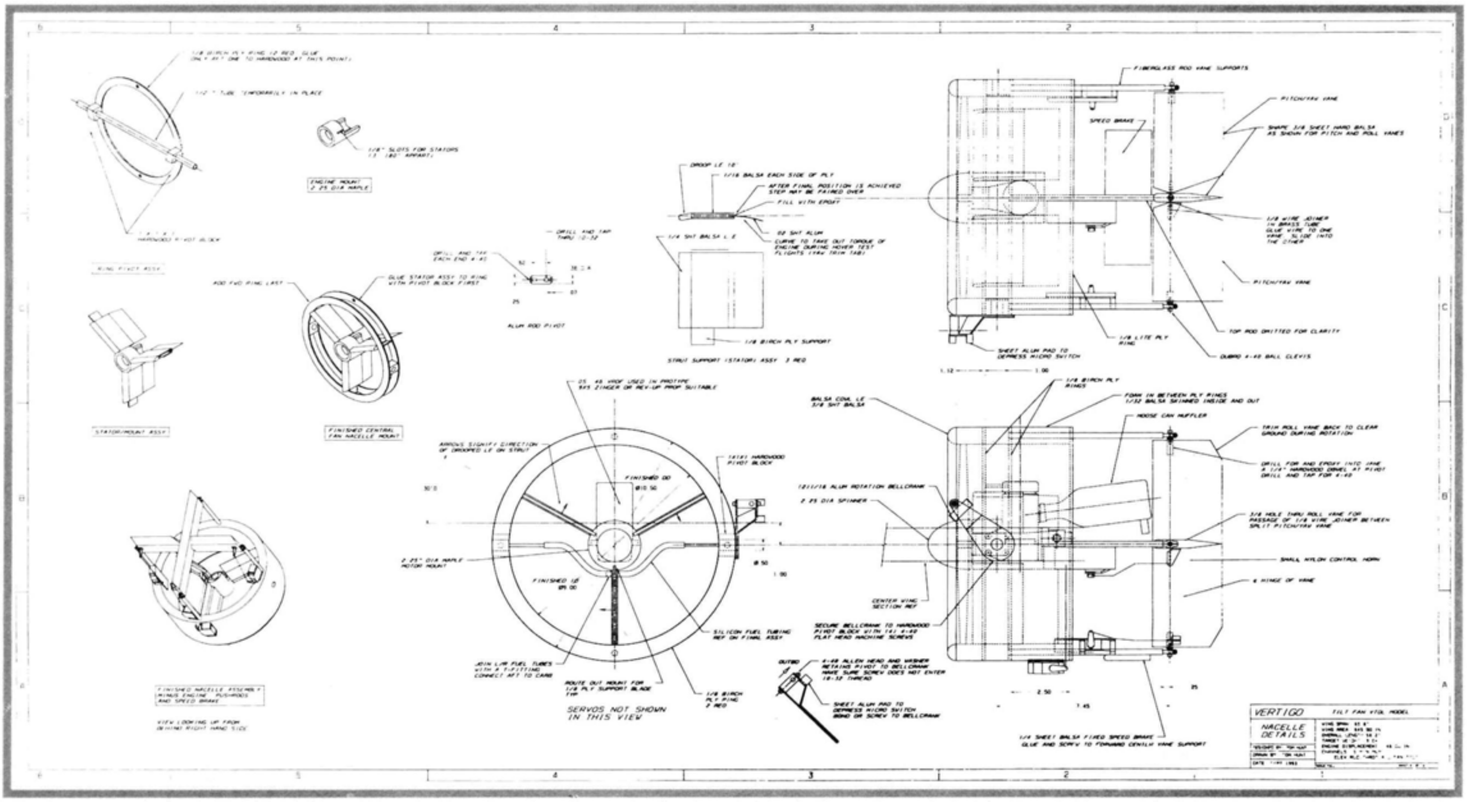
Tom Hunt starts the engine on his most recent version of the Vertigo.

THINGS THAT WORKED OK...

• **Landing gear.** The fiberglass rod (wood-filled) landing gear is still a bit flimsy if you have to make a forced landing in the rough, but it's adequate for paved or close-cut-grass surfaces for conventional horizontal landings. As presented, the landing-gear legs are more than adequate for pure vertical takeoffs and landings. If weight was not an issue, a steel tube or rod could be substituted.

• **Tail configuration.** During early flight tests, it was suspected that the horizontal tail (originally directly behind the fan) was contributing to a "pitch-up" during outbound and inbound transitions. It was later found, by moving the horizontal stabilizer to the top of the fins, that it was *not* the cause. The large round nose pod was the culprit (see "Ironing out the Bugs"). If you do not like the high tail arrangement, you could build it with the tail in the low position without adversely affecting the flight qualities.

• **Nacelle rotation.** Flight tests also revealed that the nacelle could rotate faster during the inbound transition. (The faster the better; instantaneous would be optimum, but not practical.) If I were to do this again, I would design an electrical system



Two of three plans sheets are shown. See the last issue for the other sheet.

that would use three cells for outbound (slow nacelle tilt from vertical to horizontal) and five or six cells for in-bound (fast tilt from horizontal to vertical). This would make the inbound transitions smoother without a lot of "stick jockeying."

THINGS THAT WORKED GREAT!

• **Vane control.** Do *not* attempt to modify the vane-control system. It is a well-proven system, and if it can be improved, you won't live long enough to find the answer by yourself!

• **Tilt mechanism.** The tilt-nacelle mechanism is gaudy, but it works so well that I wouldn't change a thing! Maybe a full or partial fairing would clean things up a bit.

• **Airframe.** The all-foam/balsa structure is very durable, easily repaired and very light for its strength. Substitutions should be lighter without sacrificing strength. Follow the KISS principle ("keep it simple, stupid").

FLYING THE INBOUND AND OUTBOUND TRANSITIONS

• **Outbound.** Take the model up to about a 20-foot altitude, moving ever so slightly forward by holding about half forward stick (Figure 4, frame 1). Rotate the nacelle to horizontal while still holding forward stick with the nose slightly down. The nose will rise on its own, even with forward stick applied. Let it! (Figure 4, frame 2.) About the time the nacelle reaches horizontal, release the forward stick command. The model will now be accelerating quite rapidly in whichever position the nose is pointed (Figure 4, frame 3).

• **Inbound.** Fly the model around the sky for a few laps at much reduced power (to save fuel for the inbound transition). Set up a conventional landing approach into the wind at a comfortable height. Throttle back to idle, and let the airplane stabilize in a shallow glide slope for a few seconds (Figure 3, frame 1). Throw the switch to rotate the nacelle to vertical. During the first couple of seconds, be ready with a lot of forward stick. In about 3 seconds (count them off, beginning at the moment you throw the switch), bring the throttle up to full (Figure 3, frame 2) to arrest the descent and begin the hover down to a landing (Figure 3, frame 3).

Be aware: if too much energy is carried into the inbound transition, i.e., too high a forward speed, the model may still loop. If this happens, let it complete the loop (or help it along) and return full power at the bottom of the loop. The model will settle into a stable hover rather quickly. Once stabilized, fly the model down to a perfect vertical landing. Your unknowing friends will think you planned it that way! (I won't tell if you don't.)

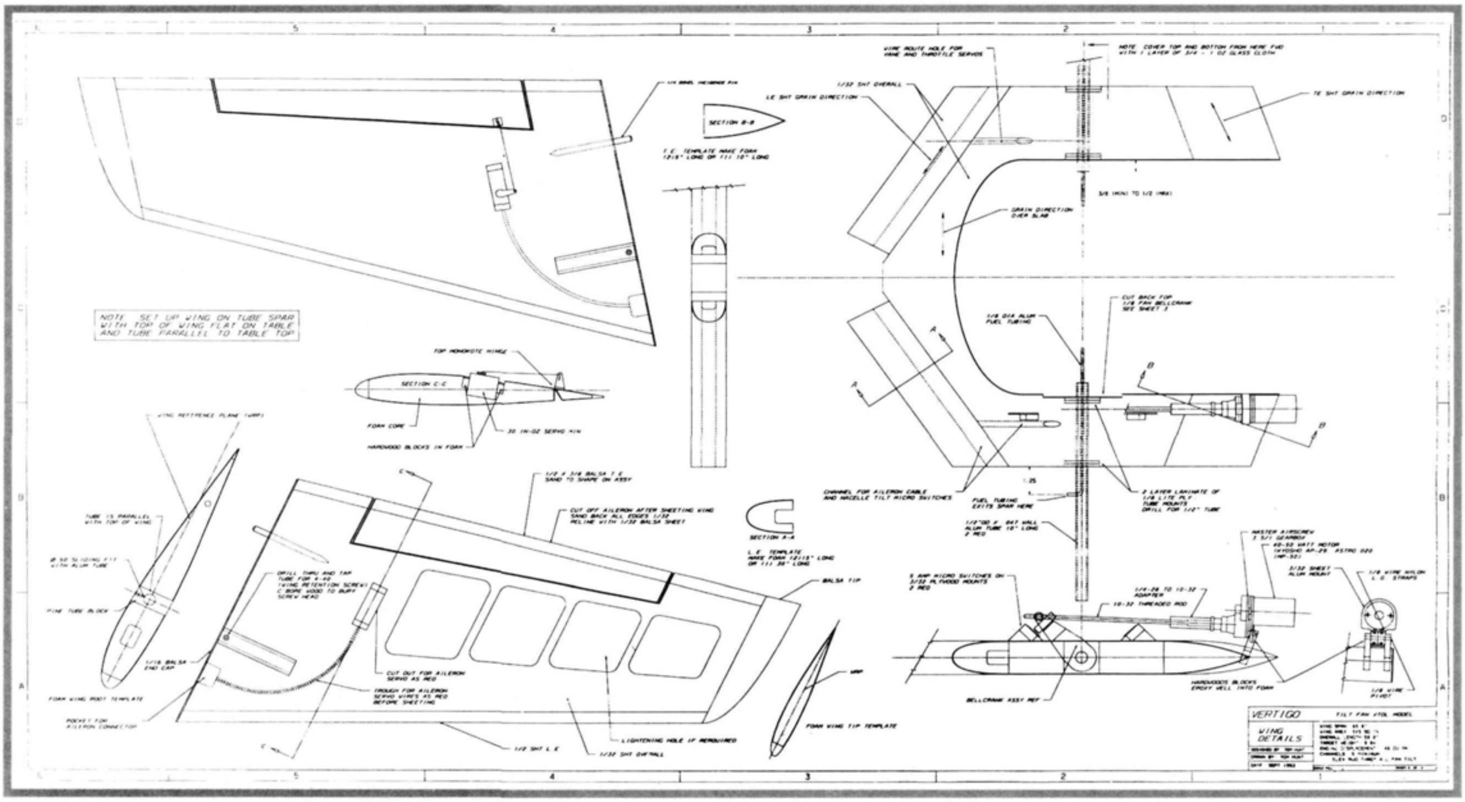
Both inbound and outbound transitions happen so fast that you will be amazed at how easy they are, regardless of how they look. The only caution I can offer the would-be builder/pilot is to not let the model back up. Backing up at altitude can disorient the pilot and cause the model to tuck under (see Figure 1). If this happens, reduce power immediately and apply full forward stick to level the model. Once the model is level, come back up with the power to slow or stop the descent.

Anytime you are in a hover and you become disoriented, make the model go somewhere—up and forward is always best. This will allow your mind to catch up and will give you enough altitude to correct mistakes. One thing this model affords you over the non-auto-rotating chopper pilots is that if you lose an engine (during horizontal flight, or the early stages of transitions), you can glide down to a horizontal landing.

WHERE DO WE GO FROM HERE?

Just as the early R/C choppers were limited in their capabilities, this first practical VTOL model is just a steppingstone to bigger (?) and better VTOL flying machines. The groundwork has been laid; the minds have been challenged. How about VTOL model contests involving precision hover flying, load-carrying events, or even racing! Let's keep the momentum going and see what other answers there are to conquering the new high ground—fast-forward-flight VTOL models!

**Addresses are listed alphabetically in the Index of Manufacturers on page 137.* ■



An innovative .40- to .50-size heli perfect for novice or hotdog pilots

MODEL AIRPLANE NEWS MAGAZINE FIELD & BENCH REVIEW

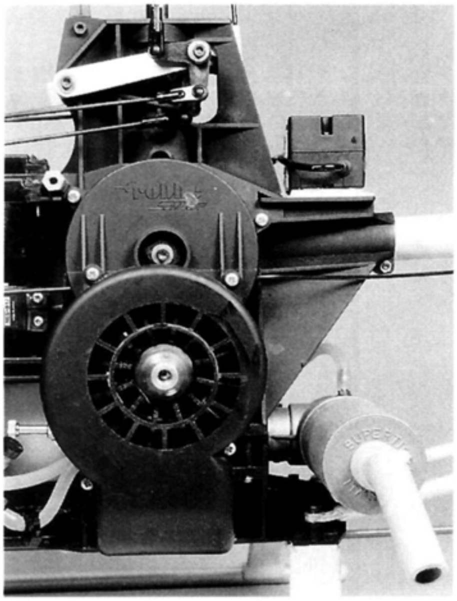
PHOTOS BY THOMAS J. TENEROWICZ & WALTER SIDAS

Robbe/Schlüter

Moskito

by THOMAS J. TENEROWICZ

DISTRIBUTED BY Pica/Robbe*, the Moskito is a new offering from Robbe/Schlüter helicopters of Germany. I have to say that Schlüter pulled out all the stops and spared no energy to bring this heli to the modeling public. They've incorporated a number of features that are generally only seen on more expensive helicopters. Among these are thrust bearings in the head, a belt drive and a tail unit that's actually a miniature rotor head with dual-bearing blade grips. This is the first helicopter I've seen that can accommodate a .40 to .50 airplane or heli engine, and the



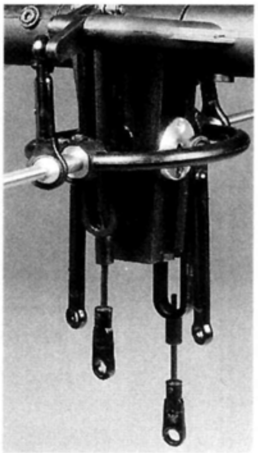
The unusual, transversely mounted engine is started on the heli's side with an electric starter that's mated with this accessible starter cone. The engine position allows the tail-rotor drive belt to run straight and twist-free.

instructions cover the installation of a helicopter or an airplane radio. Whether you're a novice who's learning to hover or an expert who wants to fly the latest in switchless inverted, this machine can meet your needs.

A LITTLE HISTORY

The first Moskito kits that came to the U.S. were designed for beginners. The main shaft was lengthened (to avoid any boom strikes), the boom was angled slightly upward (to better prevent the tail rotor from coming into contact with the ground), and the main blades were left un-weighted to reduce the complexity of blade finishing. When these kits were distributed to a few U.S. Robbe fliers for evaluation, in typical U.S. fashion, they stuffed the largest recommended engine into the airframes and had at it. With more than 25 degrees of collective throw and a power-to-weight ratio that had only been dreamed of until then, it was inevitable that the helis would be set up for switchless aerobatics. These flights revealed beginner-kit limitations that would pose problems if the helis were flown as all-out aerobatic machines. Robbe decided to upgrade all kits. They replaced the 8mm stock shaft with a 10mm one; re-engineered and strengthened the blade grips; and added a new 4mm flybar, a swashplate and factory-weighted main blades.

The result of Robbe's diligence in presenting this great kit has yielded, in my opinion, the definitive .40 to .50 helicopter in the U.S. market.



This view of the rotor head shows the Hiller loop that makes rotor assembly and adjustment easier. The rugged rotor head is representative of traditional Schlüter quality.

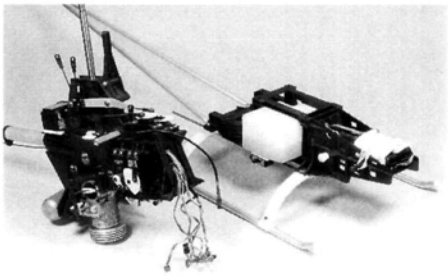
CONSTRUCTION

Start by installing the engine in its sub-assembly. For novices, any .40 airplane or helicopter engine will provide ample power to learn hovering and then forward flight. For advanced and expert pilots, a .50 will turn this docile learning machine into an "aerobiotic" beast. The engine sub-assembly comprises the engine, its mount and the power-transfer assembly. A standard centrifugal clutch, driving a reduction gear, transfers power to a transversely mounted shaft that's on top of the engine mount. The Moskito's engine is mounted transversely into the frame, like the engine in a front-wheel-drive car.

The ball-bearing-supported tail rotor is a miniature rotor head. Its placement on the upwardly angled boom avoids ground strikes.

The belt drive is powered from the transverse shaft and is captured on top of the engine sub-assembly. The system is simple to assemble, and you don't have to worry about meshing gears. The belt drive is unique in that the belt isn't twisted 90 degrees to line up with the tail output unit. Owing to the position of the power-transfer assembly, the belt runs straight to the tail gearbox, trouble-free and without any twists.

Power for the main gear is transferred from the engine by means of a bevel gear. If you install this gear on the right side of the helicopter, the main rotor will turn clockwise; install it on the left side, and it will turn counterclockwise. No scale bodies have been specifically designed for the Moskito yet, but this optional rotor rotation will lend itself nicely to scale applications.



The Moskito's unique frame setup divides the main structure. The upper half houses the engine, the servos, the tail boom and the rotor shaft. The lower half holds the landing skids, the tail-boom supports, the fuel tank and the battery pack. The halves are bolted together.

For this review, I used a Webra* .50 heli engine with a Promix carb and a SuperTigre* .40 Quiet Swing muffler. This combination worked flawlessly. The exhaust exits the Moskito's frame at the rear, allowing a number of exhaust arrangements. An optional dual-exhaust muffler is available and, for those who want to squeeze every gram of power out of their engines, Robbe offers an optional tuned-pipe clamp.

Starting is done at the side of the helicopter using a standard airplane electric starter and a starter cone that's supplied in the kit.

SPECIFICATIONS

Name: Robbe Moskito
Type: .40 to .50 helicopter
Rotor span: 47.25 in.
Weight: 6 lb.
Engine: .40 to .50 airplane or heli
No. of channels req'd: 4 to 5 (throttle, tail rotor, aileron and elevator control; collective pitch control optional)
Engine used: Webra .50 with Promix carb
Radio used: JR X-388S computer radio
List price: $439.95

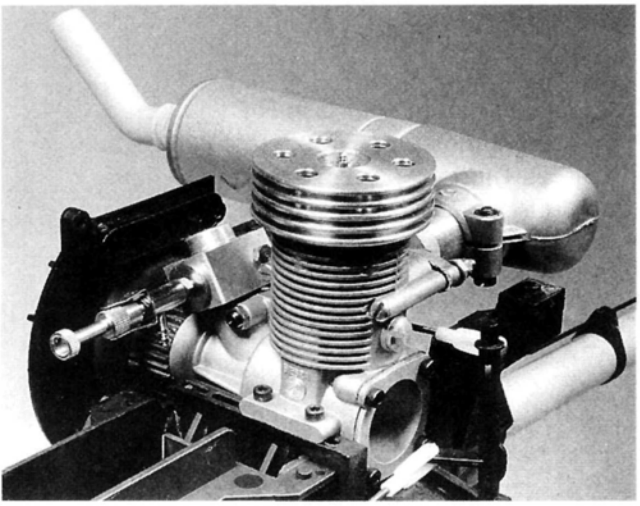
Features: the Robbe Moskito kit includes molded main frames with modular construction; a unique transverse engine mount; a belt-drive tail-rotor system; very strong, plastic tail-rotor blades; factory-weighted, symmetrical main-rotor blades; two landing gear configurations; two cockpit options; a plastic molded canopy; and a choice of two gyro positions.

Hits
- Outstanding aerobatic performance for an entry-level heli.
- More than 25 degrees of collective throw.
- Full teetering rotor head.
- Optional main rotor-head rotation (clockwise or counterclockwise).

Misses
- On some engine installations, the main frame has to be modified for needle-valve clearance.
- Given the aerobatic capability available, heavier main rotor blades (125g to 150g) would be nice. The rotor head is well-suited to the heavier blades.

AUTOROTATION CLUTCH, FRAME AND MAIN SHAFT

The Moskito uses a ratchet-type, autorotation clutch that's similar to those used in the Scout and Champion series of Schlüter helicopters. One enhancement is its simplified installation and setup. Just install the two coil springs and pins, place the ramped collar against these pins, and secure the assembly at the bottom of the main shaft with a 3mm screw and washer. With this clever design, the measuring and adjusting that were previously required to ensure that a clutch worked flawlessly are history!



The Webra .50 heli engine is a good choice for the Moskito. Coupled with a SuperTigre muffler, it provides more than enough power for aerobatic performance.

Install the completed main shaft assembly in the top half of the molded main frame. Slip a steel collar onto the main shaft, and secure it against the top bearing. Then install the engine sub-assembly in the top frame, and secure it with four 3mm bolts. The main shaft assembly is solidly captured between the upper frame and the engine sub-assembly. The main shaft can't move up or down the way it does in so many of today's designs.

You can install a standard skid-type undercarriage or an optional trike wheel with molded wheel pants. I chose the traditional skid type; I thought it would be better for a review of the Moskito used as a trainer. To join the frame halves, put the top-half's molded-in locater pins into the appropriate holes in the bottom half; then secure the halves together with four 3mm bolts and locknuts. This modular construction is quick, easy and simplifies assembly and disassembly of the frame. The main shaft can be removed without taking the frame apart.

Now that the frame, the engine and the main shaft have been assembled, install the two-piece fan shroud, the fan and the engine starting cone. Secure the shroud to the frame with six self-tapping screws. The no-maintenance shroud provides excellent cooling, and its inner section effectively seals the reduction gear. Then key the fan unit to the clutch and secure it in place along with the starter cone and the outer cooling shroud.

TAIL

The belt drive powers a very simple tail-rotor output shaft that's mounted on two bearings. A flat spot that has been machined into the shaft must be keyed with the rear toothed pulley. The belt is held securely by an idler clamp. The tail-blade holders have two bearings per blade grip, and a collar secures each blade grip to the feathering spindle. The bearings are solidly locked to the feathering spindle by a 3mm screw and washer. Slip the blade grip over the end of the feathering spindle, and secure it to the collar with two screws. This design has been used for years on Scout, Magic and Futura helicopters, and I've never seen it exhibit any problems.

The feathering spindle runs through a molded housing at the end of the output shaft. This housing comes assembled and is ready for the installation of the bearings and the blade grips. The tail-rotor blades are made of strong plastic and are ready for all the abuse novice pilots can dish out. Install the two boom supports (the strongest I've ever seen) and the molded vertical and horizontal stabilizers in the tail boom.

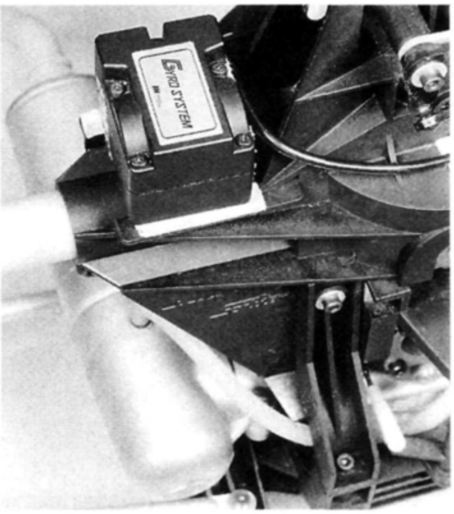
FLIGHT PERFORMANCE

From the beginning of the first test hop, it was evident that the 50-percent throttle setting using the Webra .50 provided too much power during hover; rotor speed was more than 1,700rpm. I dropped the throttle down (aren't computer radios fun?!) to 40 percent, and the helicopter became docile.

Note the maintenance instructions supplied with the Moskito. They recommend that you tighten the tail-rotor drive belt after the first flight. I didn't, and the belt began to slip. After following the instructions, I haven't had any problems.

Set up as a trainer, the helicopter is amazingly docile. It exhibited better hovering than other .50 helicopters I've seen.

Three local pilots have greatly improved their skills since they started flying Moskitos. With the pitch curves set for switchless and the unleashed power of a .50, the helicopter will become a beast in sheep's clothing. Anything a .60 switchless ship can do, this helicopter does with ease. At a local meet, a stock Moskito entered the .60 drag-race class and blew away the competition.



There are two gyro-placement options in the Moskito kit. I chose this position—just behind the main shaft—for my JR gyro.

MAIN ROTOR, BLADES AND CONTROLS

The factory-assembled main rotor has thrust bearings, and it's the teetering type that's found on most of today's helicopters. The molded Hiller-arm loop eliminates the problems beginners (and some experts) have when aligning the Hiller arms. After you've installed the Hiller-arm loop, the flybar and the paddles, balance the rotor head. I checked mine on a Robart* High-Point balancer and found that it didn't need to be adjusted.

The main blades are weighted at the factory; the ones in my kit weighed 78 and 79 grams. I balanced them and found that the lighter blade's CG was approximately 1/16 inch farther in than that of the heavier blade. Armed with this insight, I then painted the ends of the blades and the blade holders with Sig* Plastic Enamel. Two coats of paint applied to the tip of the lighter blade moved its CG out by about 1/32 inch. This brought the CG of both blades within 1/32 inch of each other—close enough for me.

Lightly sand the exposed wood using 220-grit sandpaper, and apply the stick-on blade covering. After you've installed the blades in the rotor head, balance the assembly again. I had to add a small strip of tape to the lighter blade.

I installed JR* 517 servos on all the controls except the collective, where I used a JR 4031 servo. The instructions

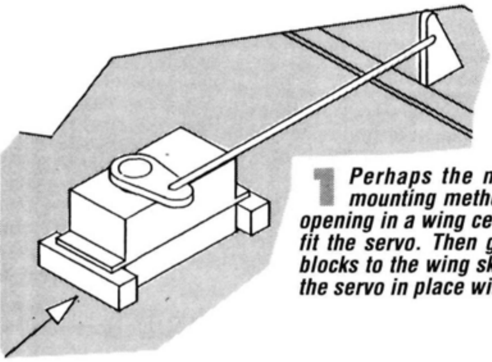
(Continued on page 123)

21 Ways to Mount Servos

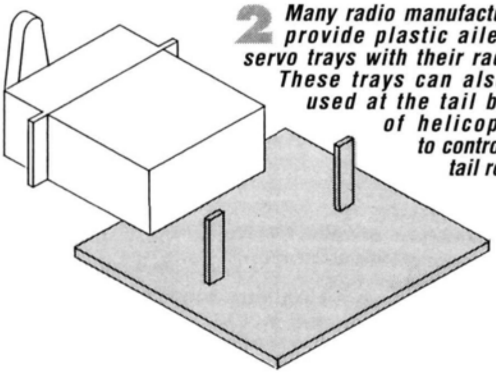
Servo installation techniques that simplify construction

by BILL GRIGGS

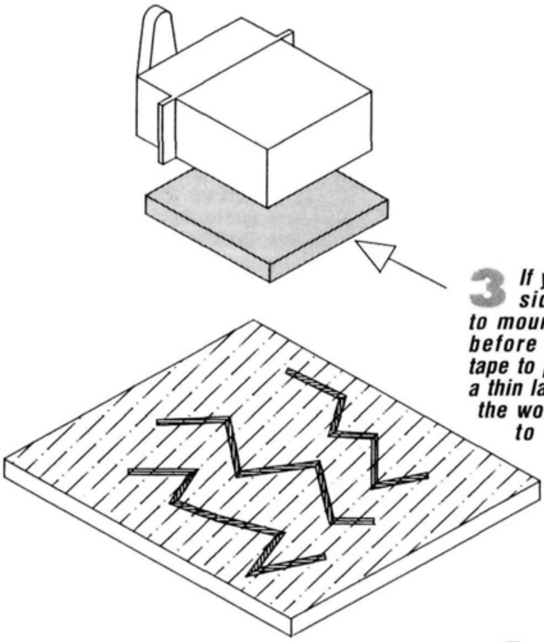
THERE ARE MANY ways to mount servos in R/C airplanes. Here are 21 ways that I've come across in the last 20 years. I've identified the sources I found, but I'm sure many have invented these techniques, or variations, independently. Many of these mounts are available commercially and can greatly simplify model construction.



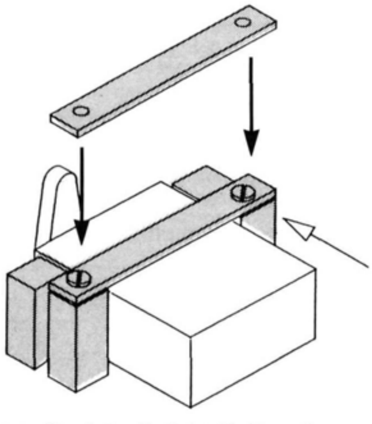
1 Perhaps the most common mounting method is to cut an opening in a wing center section to fit the servo. Then glue hardwood blocks to the wing skin, and fasten the servo in place with screws.



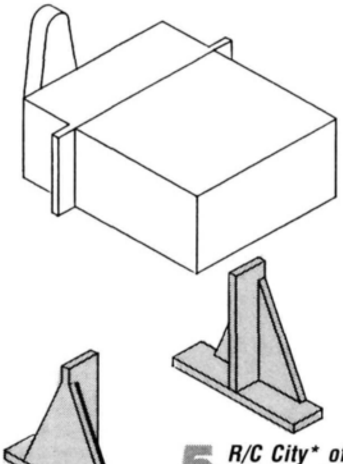
2 Many radio manufacturers provide plastic aileron-servo trays with their radios. These trays can also be used at the tail boom of helicopters to control the tail rotor.



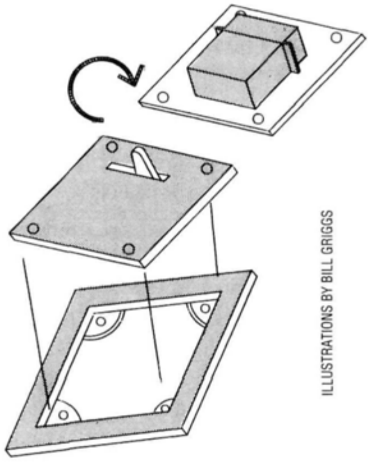
3 If you use double-sided servo tape to mount your servos, before you apply the tape to plywood, smear a thin layer of epoxy on the wood and allow it to dry. This will make the tape stick better.



4 The late Dwight Holley, former world champion sailplane pilot, mounted his aileron servos using four hardwood blocks and a plywood strap. This way, the servos can be removed quickly for maintenance.

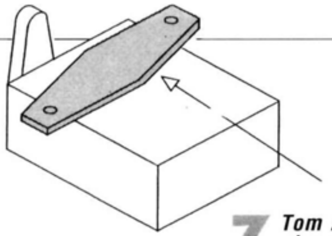


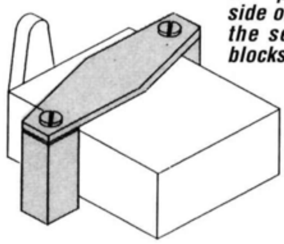
5 R/C City offers a glass-filled-nylon mount that allows you to mount servos horizontally in the wings.*



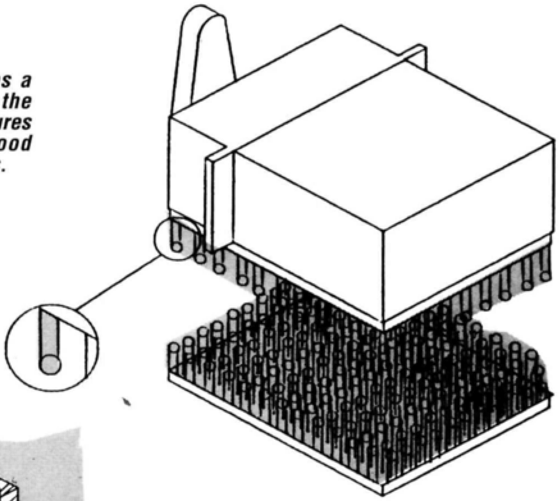
6 Soarcraft offers plywood mounting plates for foam wings. The servo is mounted on the hatch, and the plate is inset in the wing skin for a very clean installation.*

ILLUSTRATIONS BY BILL GRIGGS

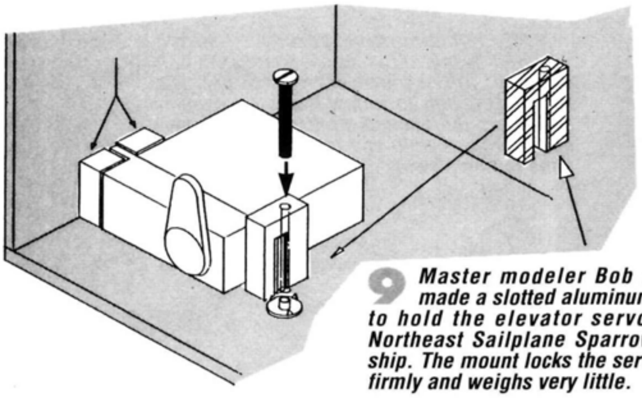




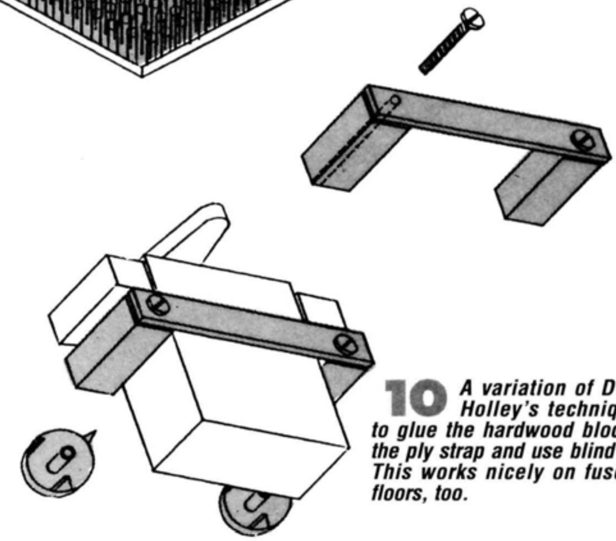
7 *Tom Atwood glues a plywood plate to the side of a servo and secures the servo with hardwood blocks and wood screws.*



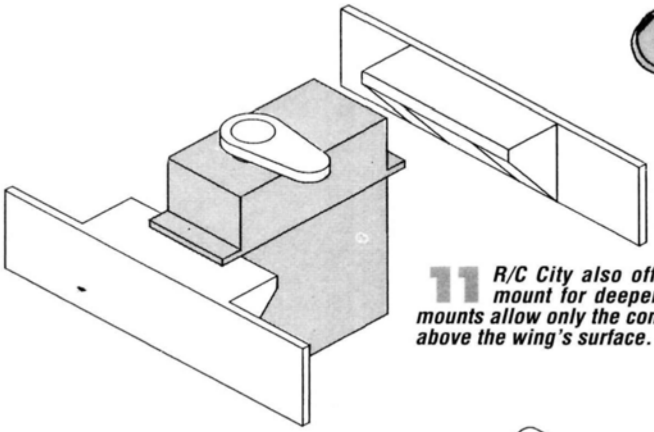
8 *Hobby Lobby's* Dual Lock unisex fastener has interlocking plastic knobs that provide a stronger grip than hook-and-loop fasteners. And unlike hook-and-loop fasteners, Dual Lock uses only one type of fastener instead of two.*



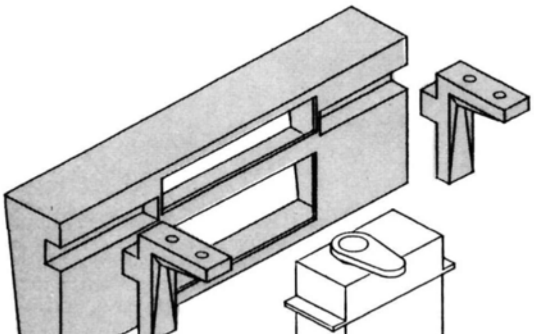
9 *Master modeler Bob Powers made a slotted aluminum mount to hold the elevator servo in his Northeast Sailplane Sparrow slope ship. The mount locks the servo down firmly and weighs very little.*



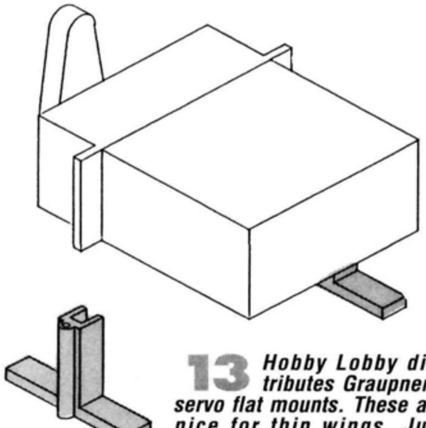
10 *A variation of Dwight Holley's technique is to glue the hardwood blocks to the ply strap and use blind nuts. This works nicely on fuselage floors, too.*



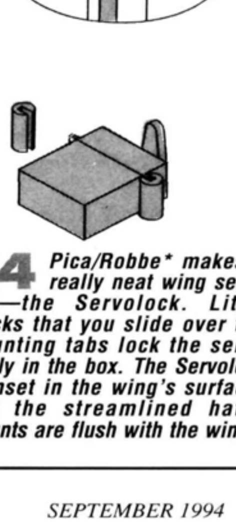
11 *R/C City also offers a vertical servo mount for deeper foam wings. These mounts allow only the control arms to protrude above the wing's surface.*



12 *Bob Violett Models* offers a carbon-fiber, side-mount servo tray for fuselage sides. It's fully adjustable to fit micro to ¼-scale servos.*

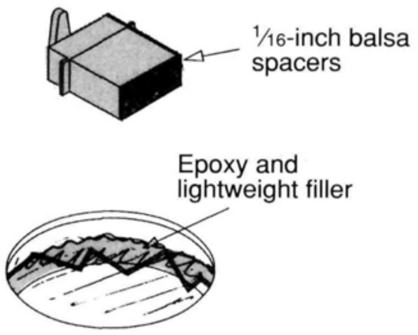


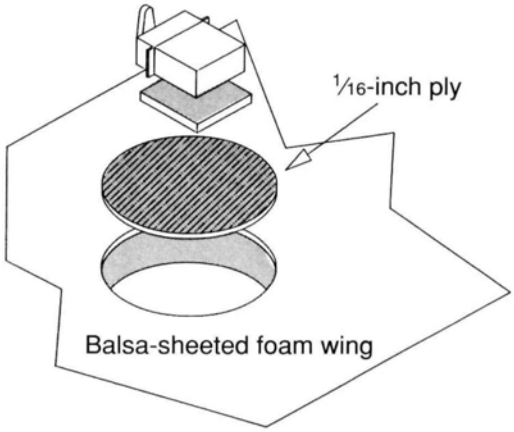
13 *Hobby Lobby distributes Graupner's servo flat mounts. These are nice for thin wings. Just slide the servo into place and secure it with screws and washers.*



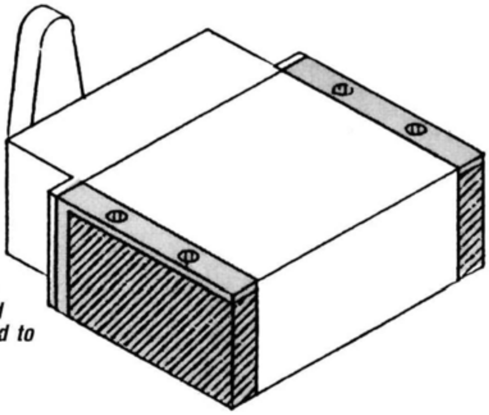
14 *Pica/Robbe* makes a really neat wing servo box—the Servolock. Little blocks that you slide over the mounting tabs lock the servo firmly in the box. The Servolock is inset in the wing's surface, and the streamlined hatch mounts are flush with the wing's*

15 ***Cutting holes in wings to mount servos can weaken the structure. To fix this, fill the hole with lightweight filler and epoxy. Tack-glue a couple of pieces of 1/16-inch balsa to one side of the servo and around the servo arm. This makes the hole slightly oversize so that the servo can be removed more easily. Then wrap the prepared servo in plastic wrap, push it into the epoxy, and let the epoxy cure.***

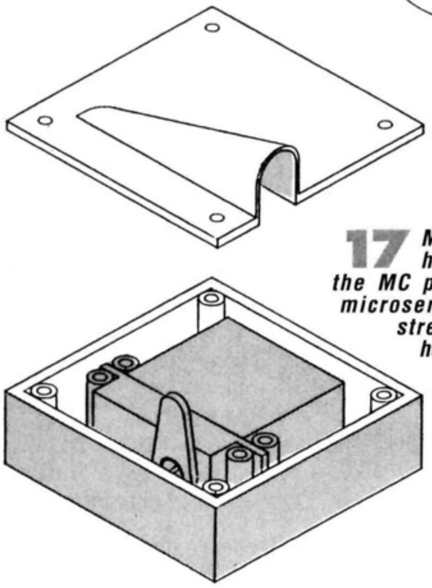




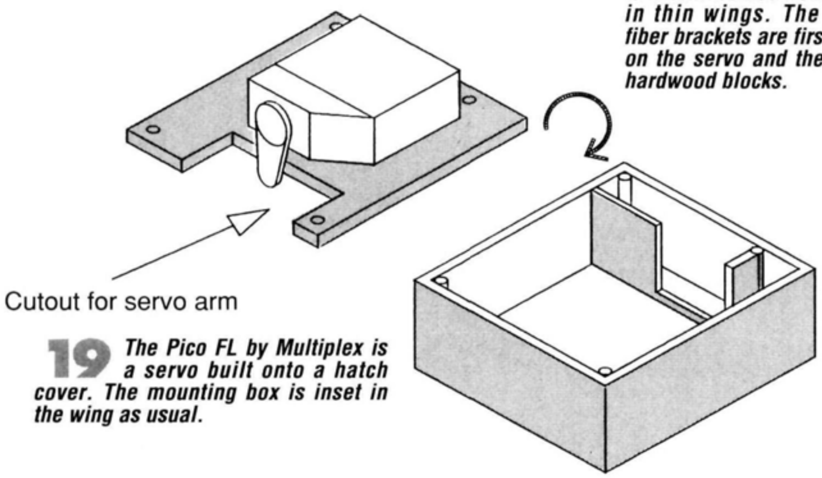
16 ***For mounting servos, 1/16-inch balsa skins don't provide much strength. Add a piece of 1/16-inch ply. It's flexible enough to follow the wing contour and offers the needed strength. During lay-up, fiberglass cloth and resin can be substituted for the plywood.***



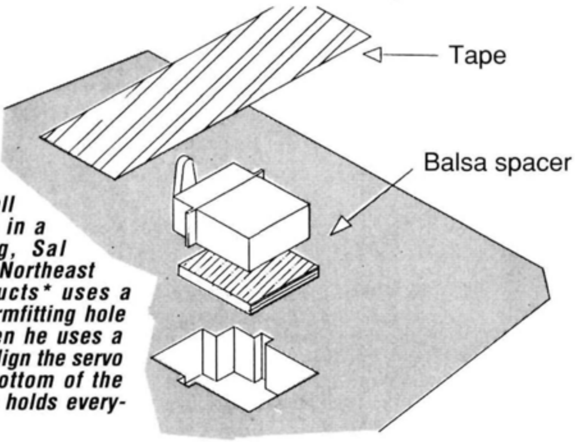
17 ***Multiplex*, a major European hobby manufacturer, offers the MC plastic servo box. Slip a microservo into the box, and the streamlined hatch cover will hold it in place.***



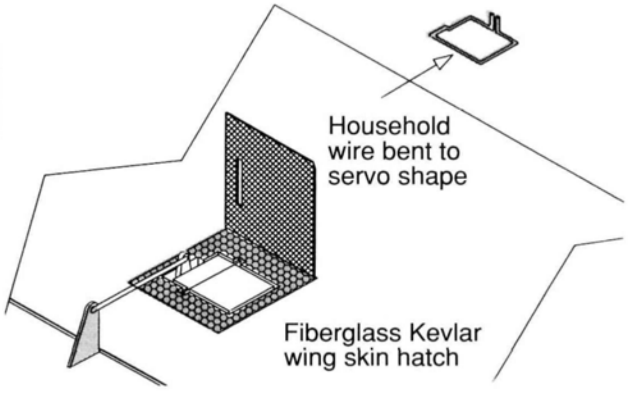
18 ***With their carbon-fiber mounts, Bob Violett Models makes it easy to mount servos horizontally in thin wings. The carbon-fiber brackets are first mounted on the servo and then screwed to hardwood blocks.***



19 ***The Pico FL by Multiplex is a servo built onto a hatch cover. The mounting box is inset in the wing as usual.***



20 ***To install a servo in a composite wing, Sal DeFrancesco of Northeast Sailplane Products* uses a razor to cut a formfitting hole in the wing. Then he uses a balsa spacer to align the servo flush with the bottom of the wing. Clear tape holds everything in place.***



21 ***Composite wing skins are strong enough to use to mount servos. Using a soldering gun and a piece of household wire that's bent in the shape of the servo, cut a formfitting cavity in the foam. The bottom wing skin can serve as a hatch cover. Cut out only three sides of the hatch; the fourth side will serve as a hinge. Applying clear tape over the hatch will make the installation almost invisible.***

**Addresses are listed alphabetically in the Index of Manufacturers on page 137.* ■

GOLDEN AGE OF R/C

HAL DeBOLT

BITTEN BY THE BUG

Quadraplex's Don Brown performed well at an early Nats with his Galloping Ghost LW Trainer.

LET'S SEE WHAT y'all have to share this time. New (?) OT'ers constantly check in with interesting info from those early days.

Nathan Rambo, former East-Coaster now in Camarillo, CA, cleaned out his photo collection and sent some interesting ones for your enjoyment.

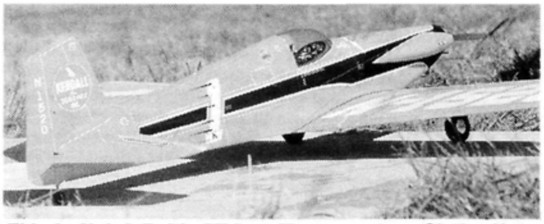
Nathan says that he'll never forget his Mac's Robot. Last month, I discussed the Robot as an early interim R/C design. Nat thinks that Fran McElwee would have denied designing this model! It was a mess; the engine fell off on nearly every landing! On the occasional flights when Nat actually had control, he celebrated by passing the transmitter key around, and all were amazed when it turned on command. Everyone lined up to give it a try. ("Passing the key" was an early ritual.) When Nat finally got reliable R/C, he always had some fine models.

All of us—even the famous—were beginners at some time. We know Don Brown as "Mr. Quadraplex" of R/C system fame and as a member of the U.S. World Champ team, so a photo of his early doings is unusual. Before he created his exotic systems, Don was an accomplished Galloping Ghost flier. Don had that system operating as it was supposed to and did well with it in his LW Trainer at an early Nats.

MAGNIFICENT MUSTANG

The photo of my Midget Mustang has a neat story behind it. When "Goodyear" pylon racing switched to the present Form I, the new rules introduced static judging that determines takeoff position. This was my attempt to take advantage of the new rule.

One year, as I prepared for the oncoming Nats, Dave Gierke dropped by and asked if he could finish my Form I Midget Mustang. Dave was noted for the outstanding finishing schemes of his control-line stunt entries—they were always Nats con-



This is Hal deBolt's Midget Mustang at an Olathe Nats. Dave Gierke provided the outstanding finish.

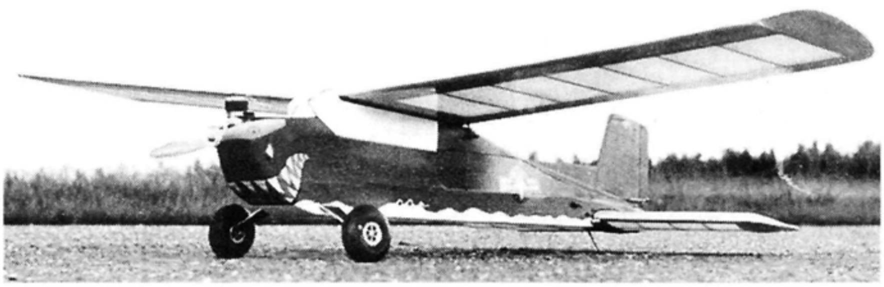
tenders—so you can imagine my reply. Of course, the photo shows the result. I was completely flabbergasted when I saw how much effort he had put into it. I doubt if there has ever been a match for it!

A side note: I used a gas cap (à la a car) with my fuel pressure system in the Midget. After fueling, extreme care had to be taken to prevent the engine from being flooded, so I couldn't tighten the cap until I was at the takeoff line. I was so excited to be the first one to take off at the Nats that I forgot to tighten the cap, and the resulting loss of pressure terminated the flight early, giving me a big, fat zero.

Don Saunders and his much-flown Roadrunner are still going strong.

BUCCANEER BRETHREN

A nice letter from A.J. Carrette of the British Virgin Islands and formerly of Belgium fills us in on some overseas OTR/C activity. The "Club due Hammyers" (hope I deciphered the name correctly) is one of Europe's oldest modeling clubs and boasts more than 100 members. Their most popular event is an OTR/C one-design gathering of Berkley Buccaneers. Some modelers increased the size and others reduced it, but all the models perform well. A.J. says that an airborne formation of Buccaneers executing a low, slow flyby is a sight to behold!



Don Saunder's mean-looking 1954 LW Senior.

A.J. asks for help with plans and info on the deHavilland Chipmunk that Robert Nelitz of Canada flew in a past World Champs. As a scale OT modeler, he would like very much to duplicate Bob's fine model. Any help would be appreciated. His address is P.O. Box 149, Roadtown, Tortola, British Virgin Islands.

COAST TO COAST NEWS

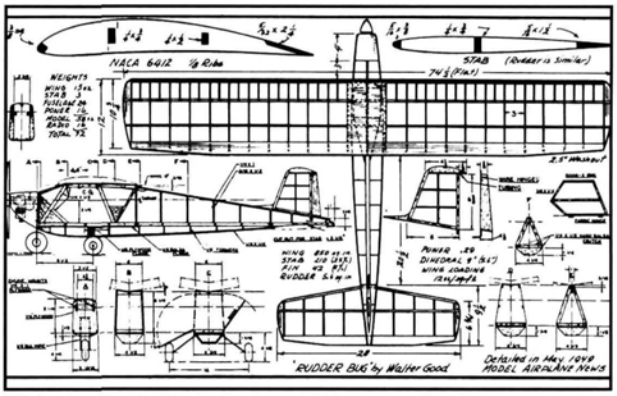
Bill Preston of East Swanzey, NH, tells us that in 1941, when he was a high school student at a Springfield, MA, technical school, he and two others built a Custom Cavalier powered by a Forester 99 and controlled by a Good Brothers-style radio. They took it to the Nats and were proud to place sixth against some strong competition. With its 9-foot span and clean lines, Shereshaw's Custom Cavalier was a popular free-flight model to convert to R/C. I can personally say it was a fine performing model, because I learned much from my OK twin-powered version. The "boys" became naval aviators and earned postwar engineering degrees. Modeling does breed successful men!

Bill also had a LW Senior that he thinks was the first R/C plane to fly in the Coupeville, WA, area. It had a K&B .19 (normal power), a two-tube Lorenz receiver, an Aerotrol transmitter and a Bonner escapement.

Don Saunders of Marysville, WA, sent a photo of his Roadrunner—a not-so-old *Model Airplane News* feature presentation. It's now several years old and is still going strong. Don says that it's a great flier. First powered by a K&B .40, it now sports an Irvine .40 diesel. Don can't say

Rudder Bug R/C Evolution

I hope that as you follow this R/C plane evolution series, you'll see the changes that occurred to create our modern craft. Already, progress is evident—from Lanzo's first "stick-style" free flight to the converted free flights to the first attempts at specialized R/C design, such as Mac's Robot.



Walt Good's Rudder Bug was a giant step between converted free flights and today's R/C planes.

The one design that actually opened the door to what we have today is Walt Good's famous Rudder Bug. Dr. Good is obviously a visionary; in areas other than R/C, he recognized the importance of the proximity used in armament, and he guided the AMA through trying times and saw R/C as the future of model aviation. When others showed him that something more than a "Big Guff"-style aircraft was needed, he put much thought into the resulting Rudder Bug. It did an admirable job and was widely modeled; perhaps the Rudder Bug helped a bit when the new citizens band caused the R/C explosion. True Bugs were scratch-built; the only kit was the smaller Royal Rudder Bug by Berkley. Bugs really dominated early '50s competition.

Let's take a look at the rudder-only design that pointed the way. Of course, the Bug still used the free-flight-style structure, although Walt conceded to the need for ruggedness with a trike gear. He once said that, more than anything else, the nose wheel was there to act as a "bumper" during the inevitable hard landings.

Here's the original Rudder Bug. Note the size of the equipment that was required for rudder only in 1949.

As models go today, the Rudder Bug was *big* with a 74-inch span, and although it was *light* at less than 5 pounds, it used only a .29 for power. Walt stayed with the free-flight-style airfoil and force arrangement, but he incorporated a symmetrical tail airfoil. The forward CG and a high thrust line were attempts to control the characteristic rudder-only "ballooning" tendency. Note that the Big Guff side-door radio access was retained, but not much else was!

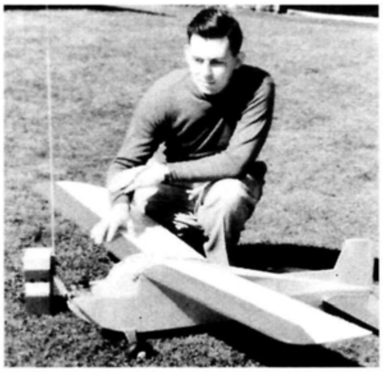
Walt Good prepares his Multi Bug at an early Nats.

Not one to have a lot of models, when Walt went to "multi-controls" with his TTPW system, the Rudder Bug became the Multi Bug with the addition of engine and elevator controls.

To say that the Rudder Bug had a positive influence on the progress of R/C would be putting it mildly. I was one of many who first cut their R/C teeth with the Bug, and we all appreciated it!

enough about the diesel engine and indicates that it's very potent.

Another photo continues the LW Senior saga. Don's 1954 Senior had an outstanding paint scheme. Considering the generally short lives of early R/C planes, modelers didn't usually spend time on neat paint schemes. Don's Senior was powered by a Forester .29 (above-normal power for this early model),



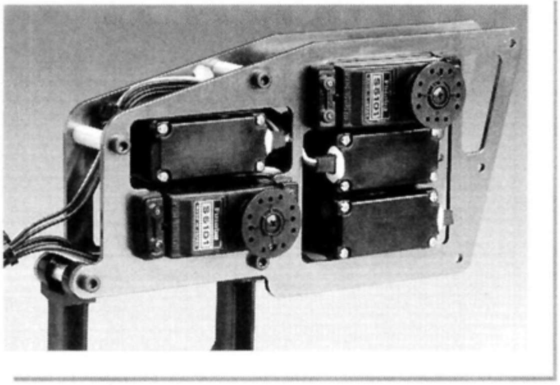
Bill Preston shows off his 1953 LW Senior.

and it used a Babcock 3-channel tone system. He says that it flew well for several years. The only problem was that the Bonner "mailbox" elevator servo tended to creep toward down-elevator in flight, and that resulted in some hair-raising speed runs!

I'm sure that many of you appreciate Andy Lennon's prolific presentations on aerodynamics, but you may not realize how far back he goes. Andy is surely a "senior" modeler. He indicates that the first of the Arden .099-powered beauties flew out of sight on one of its initial flights. Andy tells me that the force arrangement I advocated worked very well on this early model.

And so it was (and is) at your OTR/C place—great times and fine modeling! ■

NEW HELI PRODUCTS



GREAT PLANES
Heli-Max Concept 30 Metal Servo-Frame Set

Developed to increase rigidity for reduced flex in the SR and DX models, this servo-frame set can improve precision for all-out 3D flying in addition to lowering flex. It has a simple design with few parts, so servo installation is fast and easy. Its anodized finish helps to reduce oxidation. The set uses the models' original mounting screws and servo-mounting plates. All special fasteners and spacers (mounting hardware) are included.

Part no.—HMXE4822; **price**—$44.99.

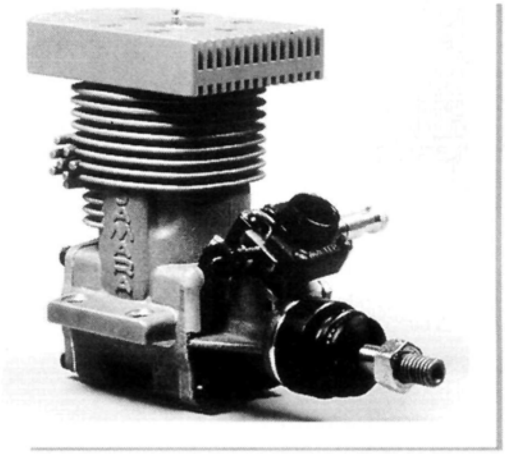
Heli-Max; distributed by Great Planes Model Distributors, P.O. Box 9021, Champaign, IL 61826-9021; (217) 398-6300.

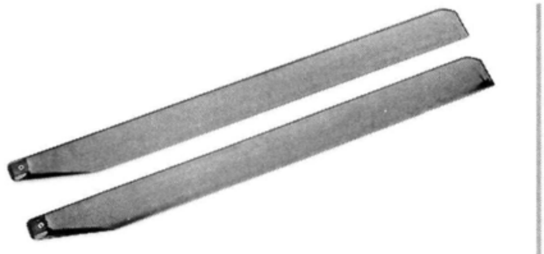
JAMARA
MX80 Heli Engine

This high-torque engine for large machines features a heat-sink head and a sliding-valve carburetor. It's fitted with an ABC piston/liner with four transports, and this guarantees high power at low revolutions. The MX80 is available with rear and side exhausts. Specifications: bore—0.9961 inch; stroke—0.9842 inch; piston displacement—0.80ci; rpm—2,000 to 18,000; weight—20 ounces.

Part nos.—11 5000 (rear); 11 5010 (side); **price**—$212.50 (twin ball bearing).

Jamara; exclusively distributed by Alpha USA, 55 Leveroni Ct., Novato, CA 94949; (800) 685-8290 or (415) 884-3030; fax: (415) 884-3033.





NHP
Rotor Blades

Featuring the latest in composite technology, each blade consists of a 100-percent carbon-graphite-composite outer skin with a foam-core center. All NHP blades feature leading-edge, CG-corrected tip weight for optimum performance.

A high-compression steel mold ensures accuracy and incomparable blade weight consistency. Because of graphite's tensile strength and inelasticity, the torsional and longitudinal rigidity of NHP blades is unmatched. The blades pictured are the same blade design Curtis Youngblood used to win the F3C World Championship title.

NHP offers a wide range of rotor blades in both .30 and .60 sizes with full symmetrical and semisymmetrical airfoils.

Part no.—VRT680C; **price**—$174.95.

NHP, distributed by Horizon Hobby Distributors, 4105 Fieldstone Rd., Champaign, IL 61821; (217) 355-9511.

(Continued from page 6)

EDITORIAL

Planes with a wing loading of 15 ounces per square foot or lower may compete in this class.

• **Internal Combustion, Class B—"Conventional Aircraft."** This class is open to aircraft with wing loadings of 20 or more ounces per square foot. The wing loading may be lower than this range with high-lift devices deployed.

• **Time trials.** Time trials will be held outdoors, with flight times the average of an upwind and downwind pass. Slow flight will be measured along a 100-foot strip that's no more than 20 feet wide (planes must stay within the strip). High-speed passes will be made along a 500-foot strip. Callers will time the passes or coordinate with a timer; radar guns may be used.

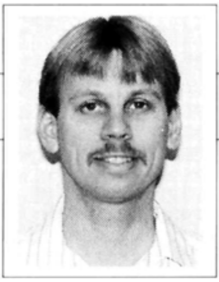
• **Indoor Electric Class C.** This is an unlimited class, but planes must be powered by electric motors running on commercially available Ni-Cd batteries. The use of off-the-shelf components is recommended but not mandated. The plane must be able to fly at least two circuits around the perimeter of an indoor basketball court on one charge. It must be able to do a figure-8 within the court, although not necessarily on the same run as the laps. Slow flight will be measured along a 50-foot course that is 15 feet wide. It is impractical to fly a model at anything but very slow speed in a regulation, professional basketball-size gym, so there is no high-speed requirement. If two models were tied for slow speed, and one demonstrated an outdoor high-speed capability, the judges could take this into consideration, but they are not asked to do so.

7. Scoring. A point system will be used in the internal-combustion engine classes that weighs heavily in favor of slow flight but that also rewards total performance envelope. This system allocates 20 points per mph under 30mph, and two points per mph above 30mph. If you can hover and fly in full control at any speed up to 50mph, you would earn 640 points. Hovering is not a requirement. For a hover to count, it must be sustained for at least 30 seconds in zero wind conditions. For maximum points, the aircraft must be able to transition from hover, in flight, to continuous forward motion at gradations of low speed.

8. Wind speed. Contestants are required to fly an upwind and downwind course, and they should seek atmospheric conditions that minimize the presence of sidewind. If, in a slow-speed run, the forward speed of the aircraft is less than the wind speed, the aircraft would fly backwards on the upwind leg. For the sake of accuracy in measuring performance, we recommend that testing be done in no-wind conditions or where the wind speed is less than the aircraft's speed. Prevailing wind conditions at the time of the record course run must be documented.

9: Appearance and K Factor. There is no premium put on scale appearance; we are not requiring that the aircraft ROG or have landing gear (but an aircraft must be flyable after it lands). The ability to perform loops, rolls or other aerobatics could be used by the judges to determine, for example, which of two designs with equal slow-flight capability should get the edge. The judges are not required to consider this but may at their option. ■

CENTER ON LIFT



MICHAEL LACHOWSKI

T-TAIL ELEVATOR LINKAGES

THIS MONTH, I want to take a look at some linkages—the T-tail elevator linkage in particular. It presents a challenging problem, as each extra pivot and clevis adds more slop. We also have to make sure that the elevator works well, and I'll tell you how to determine whether you have enough travel on the elevator. Finally, I'm sure that everyone is enjoying some excellent summer soaring weather, so I have some tips on making your long flights more interesting.

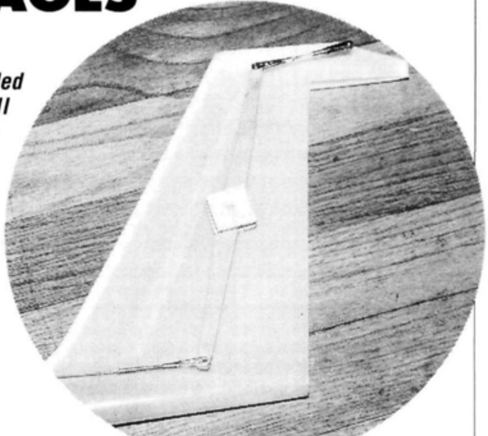
T-TAIL ELEVATOR LINKAGE

I prefer the looks of a sailplane with a T-tail, but there are some problems with T-tails, primarily with the elevator linkages. That linkage has to operate the elevator, yet there is no way to directly link the servo and elevator. Here are some techniques I have used and found to provide positive control for T-tail elevators.

The best methods I have found for a forward-mounted elevator servo all involve a bellcrank or a rocker that pivots in the fin. Figure 1 shows a 90-degree bellcrank used to operate the elevator. One thing to note is the elevator-horn location. The horn is forward of the elevator leading edge, so the bellcrank can directly drive the elevator. The bellcrank should be large (1½ to 2 inches from the pivot to the pushrod attachments). I like to use a fiberglass plate and a ball bearing for the pivot. You can make a very tight-fitting pivot and take advantage of the smooth operation and minimal slop of a good bearing. Make sure that the elevator-horn hole is above the hinge line; otherwise, you may have problems getting as much up-elevator travel as you want. One advantage of this linkage is that the servo pulls for up-elevator.

If you want a more conventional elevator-horn position, a rocker provides a good solution (see Figure 2). The rocker should be stiff and not able to flex or twist. You can mount the pivot inside the fin, or you can build a pivot on the rudder post. Then slide in the whole assembly when you glue in the rudder post. This makes it easier to line up and install the pivot. One nice part about this method is that you can enclose the elevator horn in the fin. The Spectrum* uses this technique to provide a nice, clean mount.

You can also mount elevator



The rocker linkage included in the Spectrum. It's all plywood with an aluminum pivot.

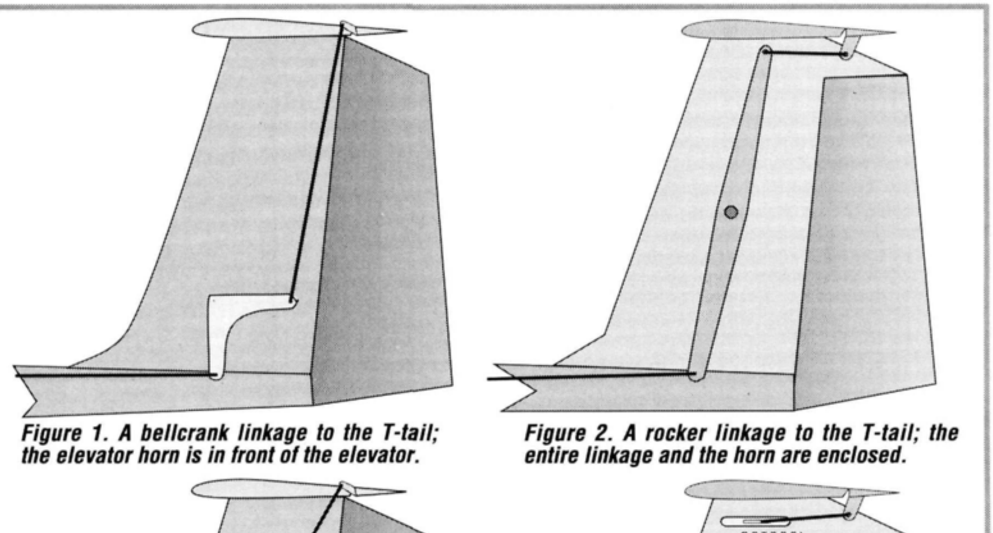


Figure 1. A bellcrank linkage to the T-tail; the elevator horn is in front of the elevator.

Figure 2. A rocker linkage to the T-tail; the entire linkage and the horn are enclosed.

Figure 3. A direct-drive linkage from the elevator servo (mounted in the fin) to the elevator. The fin has to be wide enough to accommodate the servo and the servo arm.

Figure 4. The elevator servo is mounted in the top of the fin. The servo arm protrudes out of the side of the fin to an offset horn. Make sure that the base of the fin is well-designed and reinforced.

servos in the fin. If you compare the weight of a servo in the fin (plus servo extension wires) with that of a conventional pushrod, you'll find that there is no weight penalty with the servo. You can argue that mounting the servo in the fin is worse because more mass is farther from the CG, but most pilots won't notice the difference. One technique for mounting the servo is to position it near the bottom of the fin and use a pushrod that's enclosed within the fin to drive the elevator (see Figure 3). This can be hard to do on smaller models, and you might have to add a bubble to the side of the fin to provide enough room for the servo arm. A second approach is to have the servo arm extend outside the fin. A short pushrod connects it to a control horn on the elevator (see Figure 4). The Surprise* III F5B electric uses this technique. I've also seen it used successfully on both rudder and elevator control surfaces on a cross-country sailplane.

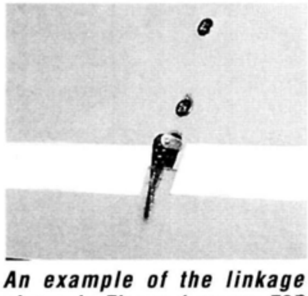
This is hardly a complete list of the things I have seen tried. I'm sure some readers out there have some other approaches that work just as well as these. Experimenting and trying new ideas makes the sport more interesting.

SUMMER SOARING TIPS

It's a beautiful day, and there's plenty of lift. You enter a strong thermal upwind of the turnaround and are really high by the time you drift back to the winches. You have two choices now: test your eyesight, or increase your understanding of thermals and your ability to locate lift and fly through sink. All too often, I see sport pilots just stay with the thermal until their planes are tiny dots in the sky. It's no fun when you have to help your buddy bring this thing down. Worse yet is searching the sky for a lost sailplane.

My usual approach is to leave the lift, but sometimes, I like to practice inverted thermalling. You can now do a few things to improve your flying skills. First, practice judging how fast lift is moving downwind. Fly away from the lift for a minute; then point your sailplane toward the area where you think the lift has drifted. Did you get it right? You also want to note any down-air conditions you fly through before finding the lift. Remember to fly through these areas more quickly. What have you learned? You know what it's like flying through the down air behind a thermal. When you're charging through sink to get to the lift that's just a little farther downwind, confidence is important. You've seen how far lift can drift in a minute. Now, when you step up to the winch, you can decide whether you want to charge downwind for the lift the pilot in the landing pattern was in while you were waiting for a winch line.

You can also search for other lift. There's nothing more satisfying than flying many thermals during a flight. You don't want to fly directly upwind. This has the highest probability of being the wrong area in which to fly, and you'll be setting up for a landing approach, not flying in a thermal. A zigzag search pattern works well, but the first leg is the important one. For strong thermals, I fly far away from the thermal—often all the way to the other side of the field. It's amazing how often you can find another thermal just by flying 45 degrees crosswind (and how often you'll see other pilots who, sticking with the first thermal, fly straight upwind and land before you do).



An example of the linkage shown in Figure 1 on my F3B original design. The horn is above the fin because the hinge line is on the top surface.

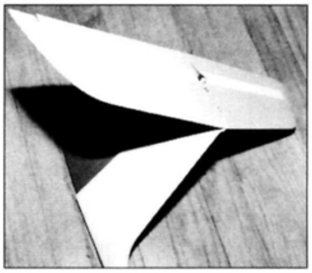
The crosswind flying concept also works for getting down from high altitude. The biggest problem in diving out of lift from a high altitude is lack of visibility. While circling, you can see the planform during part of the circle, but the glider might disappear while it's pointed directly toward you. Exiting the thermal and flying so that you can see the wing and the side of the fuselage will improve visibility. If there are some clouds, plan your flight path so that they are in the background. Eventually, you'll get down to an altitude at which you no longer have a visibility problem.

**Addresses are listed alphabetically in the Index of Manufacturers on page 137.* ■

ELEVATOR EFFECTIVENESS

Let's take a look at the elevator itself and its effectiveness. Usually, you don't need that much elevator travel for soaring, but you really need it for landing and quick turns at high speeds.

Many people confuse the elevator's size with its effectiveness. In reality, making the elevator chord more than 30 percent of the stab's chord adds very little to its effectiveness. You get some minor gains and, of course, you could go all the way and build a full flying stabilizer. The wider chord does invite other problems, however, particularly elevator flutter. A wider, heavier elevator is more prone to flutter at high speeds than a narrow elevator.



The real key is in the deflection angle. To get the nose down for that downwind landing, try to get 30 degrees deflection. Going much beyond 30 degrees causes problems with the airflow over the surface. Of course, the guaranteed way to make an elevator more effective is to move the CG back. We have to strike a balance between stability and control.

Next time, before you complain that the designer didn't make the elevator wide enough, check the deflection angle.

AEROBATICS MADE EASY

DAVE PATRICK

SOMETHING FOR EVERYONE!

THIS MONTH and next, I would like to discuss the various types of R/C aerobatic flying, the different types of events and their characteristic maneuvers and the different types of aircraft required. There really is something for everyone in this great sport! I will launch the discussion by dealing with the aerobatic events with which I am most familiar. Whether you wish to take up the challenge and compete, or you just want to expand your aerobatic repertoire, much fun is in store!

PHOTOS BY DAVE PATRICK

This Goldberg Tiger .60 would be a very competitive choice for novice and sportsman classes. Powered by a sport .60 engine and controlled with a middle-range Futaba 7 UAP or a similar radio, this model will serve the beginner well.

IN THE BEGINNING....

The aerobatics heritage really began when R/C was in its infancy. At that time, it was a great day and a major feat just to complete a flight successfully. Performing a simple loop or a roll was really accomplishing something special. In the early days (early '50s), competitive events were based on tasks such as "proto taxiing," which meant you had to show you had control taxiing on the ground and while taking off, and could also perform maybe a loop or a roll while airborne, and then a landing within a circle. You then had to stop, then taxi back to the starting point. Much of the time, the winner was the survivor!

As technology improved, so did pilot skills. Over the years, competition played a large part in motivating us (and I'm referring to grassroots R/C hobbyists/sportsmen) to push technology forward. Today, we're seeing products that are vastly superior and, most significantly, when adjusted for inflation, less expensive. So, when I fire up my Futaba* 9 Zaps, push a few buttons on my menu-driven screen, aim my 120cc (7.3ci) powered TOC (Tournament of Champions) plane for the wild blue, I'm still in awe. I clearly remember when I had to wind up my escapement in my Carl Goldberg Models Jr. Falcon and toss it into the wild blue (perhaps never to see it again!).

Technology has improved so much since our humble beginnings that our pilot skills had to follow suit. A Futaba 9 ZAPS computer radio and the Finesse is a great combination for competition, but it isn't required to get started in aerobatics.

SPORT AEROBATICS—FOR THE FUN OF IT!

We all start here in sport aerobatics (and, of course, many stay). I view this to be the point where you've performed your first loop or roll. In a sense, you may still be at this level even if you've achieved more advanced maneuvers, such as tumbles and rolling circles. A lot of fliers are quite happy being able to perform a simple loop and a roll with a basic trainer, and I totally respect that concept. After all, this is supposed to be fun!

I recently met a modeler in Las Vegas who had two beautifully prepared Finesses (a top-of-the-line aerobatic, i.e., pattern, competition plane), and while admiring his effort, I asked what pattern class he flew in.

"Oh, I don't compete" he replied, "I built these because I love the way they fly!" He is, no doubt, a highly dedicated sport modeler.

By far, the largest group of fliers are sport aerobatic modelers. These are the modelers who attempt something more than straight and level flight, and, in the course of their R/C careers, will fly almost anything. They benefit greatly by learning how to maneuver their aircraft through various aerobatic patterns; flying skills are really honed, especially when aircraft are positioned in unusual attitudes. These skills also produce pilots with better safety records.

There are a few of us who try our hand at competition. When we do, we have to decide what event we want to try our hand (thumbs?) at. This is the point where we start to become specialized in aerobatics by flying specific maneuvers with special aircraft.

AEROBATICS CATEGORIES

Here are the basic categories of R/C aerobatics:

- **Pattern**—.60 2-stroke- to 1.20 4-stroke-powered planes that fly very specific maneuvers and are judged on grace and precision.
- **IMAC**—falls under the umbrella of the International Miniature Aircraft Association. In IMAC competition, you fly scale-like aircraft through a series of scale aerobatic maneuvers in an attempt to emulate the performance of full-size planes.
- **Competition fun fly**—sponsored by the National Competition Fun Fly Association (NCFFA), this category is strictly task-oriented. You attempt, for example, to do a specified number of loops and/or rolls as quickly as you can. From this segment came the "roops" concept (takeoff, loop, roll, touch and go, and do it again). Generally speaking, very light, .30-size models with low aspect ratios and carbon-fiber-boom "fuselages" are flown in this class.
- **TOC**—the Tournament of Champions category is very similar to IMAC, but it focuses on one major competition every

PATTERN MANEUVERS

One of the great things about pattern is the wide range of classes; there really is something for everyone. The following are the five AMA classes and two FAI (F3A) classes with maneuvers flown in each. The "K" is a factor applied to the score that reflects the difficulty of the maneuver. The higher the K factor, the greater the difficulty. (Note: (U) means upwind, (D) means downwind.)

NOVICE

Novice pattern maneuvers

1. Takeoff (U)	k=1
2. Straight flight out (U)	k=1
3. One-half reverse Cuban-8	k=1
4. Straight flight back (D)	k=1
5. Stall turn (U)	k=2
6. Immelmann turn (U)	k=2
7. Split-S	k=1
8. Three inside loops (U)	k=3
9. One horizontal roll (D)	k=1
10. Landing (U)	k=1
Total	k=14

SPORTSMAN

Sportsman pattern maneuvers

1. Takeoff (U)	k=1
2. Double stall turn (U)	k=3
3. One-half reverse Cuban-8	k=1
4. Cuban-8 (D)	k=2
5. Immelmann turn (U)	k=2
6. Split-S	k=1
7. Three inside loops (U)	k=3
8. Straight inverted flight (D)	k=1
9. Stall turn	k=2
10. One reverse outside loop (U)	k=3
11. Three horizontal rolls (D)	k=3
12. One-half Cuban-8	k=1
13. Square loop	k=2
14. Landing (U)	k=1
Total	k=26

ADVANCED

Advanced pattern maneuvers

1. Takeoff (U)	k=1
2. Double Immelmann (U)	k=2
3. One-half reverse Cuban-8	k=1
4. Slow roll (D)	k=3
5. Stall turn	k=2
6. Top hat with 1/2 roll (U)	k=3
7. Humpty bump with options	k=2
8. Four-point roll (D)	k=4
9. Stall turn with 1/2 roll	k=2
10. Cobra two-point roll (U)	k=2
11. Immelmann turn	k=2
12. Six-sided outside loop (D)	k=4
13. Split-S	k=1
14. Avalanche (U)	k=3
15. Top hat with 1/4 roll	k=2
16. Triangle rolling loop (D)	k=4
17. One half square loop with 1/2 roll	k=2
18. Three turn spins (U)	k=3
19. Landing (U)	k=1
Total	k=44

MASTERS

Masters pattern maneuvers

1. Takeoff (U)	k=1
2. Square loop with four half rolls (U)	k=5
3. Half reverse Cuban-8	k=1
4. Four-point roll (D)	k=4
5. Immelmann turn	k=2
6. Reverse top hat (U)	k=4
7. One-and-a-half turn spin	k=3
8. Square horizontal eight (D)	k=5
9. Top hat with 1/4 roll	k=2
10. Avalanche (U)	k=3
11. Half Cuban-8	k=1
12. Triangle rolling loop (D)	k=4
13. Stall turn with 1/2 roll	k=2
14. Cobra point roll with 1/4 up and down (U)	k=3
15. Half square loop with 1/2 roll in vertical	k=2
16. Six-sided outside loop	k=4
17. Split-S	k=1
18. Figure M with 1/2 roll (U)	k=5
19. Humpty bump with pilot's option	k=2
20. Reverse knife-edge (D)	k=4
21. Half square loop with full roll in vertical	k=3
22. Three-turn inverted spin (U)	k=4
23. Landing (U)	k=1
Total	k=66

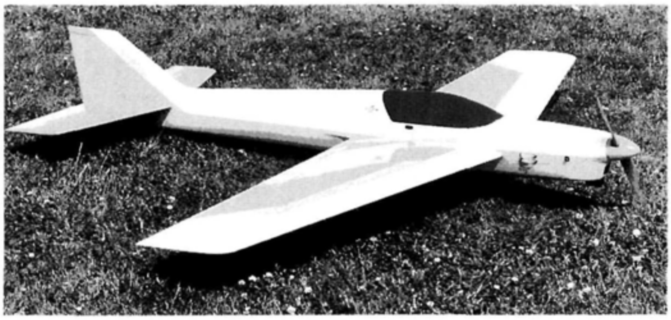
FAI F3A (B)

B1. Takeoff sequence	k=1
B2. Figure M with 3/4 rolls	k=5
B3. Figure 9, pull to vertical, 3/4 outside loop	k=1
B4. Square vertical 8, inverted entry	k=5
B5. Half loop	k=1
B6. Pull-push humpty bump, 1/2 roll up 2/4 point roll down	k=3
B7. Top hat,1/4 rolls	k=2
B8. Inside-outside Cuban-8, full rolls	k=4
B9. Half square loop 1/2 roll up	k=2
B10. Reverse top hat	k=4
B11. Two and one-half turn spin	k=3
B12. Triangle rolling loop	k=4
B13. Stall turn, 1/2 rolls	k=2
B14. Vertical eight from the bottom	k=3
B15. Pull-push humpty-bump, 1/2 roll down	k=2
B16. Slow roll	k=3
B17. One-half Cuban-8, 11/2 snap down	k=3
B18. Square loop, 1/2 rolls	k=5
B19. Humpty-bump (pilot option)	k=2
B20. Two of four-point roll,opposite directions	k=5
B21. Stall turn, full roll up and down	k=3
B22. Hour glass	k=4
B23. Landing sequence	k=1
Total	k=68

FAI F3A (C)

C1. Takeoff sequence	k=1
C2. Reverse Cuban-8	k=3
C3. Stall turn, 1/2 rolls	k=2
C4. Slow roll	k=3
C5. Half square loop	k=1
C6. 45 degrees down, negative snap roll	k=4
C7. Humpty bump with rolls (pilot option)	k=2
C8. Four-point roll	k=4
C9. Half loop	k=1
C10. Square horizontal eight, inverted entry	k=5
C11. Inverted spin, two turns	k=3
C12. Double Immelmann with full rolls	k=4
C13. Top hat with 1/4 rolls, inverted exit	k=2
C14. Two loops with two half rolls	k=4
C15. Half square loop with full rolls	k=3
C16. Square loop on corner	k=4
C17. Half square loop with 2/4 point roll down	k=2
C18. Figure M with 3/4 rolls	k=5
C19. Stall turn	k=2
C20. Two of two-point roll, opposite direction	k=4
C21. Immelmann turn	k=2
C22. Spin, reversed, 2 turns each	k=4
C23. Landing sequence	k=1
Total	k=66

(B—preliminary; C—finals)



The Finesse is a top of the line Precision Aerobatic F3A design and a good choice for advanced and masters competitions. Many modelers enjoy the model simply because they like how it flies non-competitively.

other year. A select group of contestants, usually less than two dozen, are invited from around the world to compete.

Let's look at these competitions in greater detail.

PATTERN OR PRECISION AEROBATICS F3A

This event is very well-established and somewhat selective; only the better pilots tend to have what it takes to fly precision aerobatics. The maneuvers are very specific, but you do have a good deal of latitude in terms of the aircraft you can fly. It's probably very similar to figure skating. You can wear any type of skates, but you're closely scrutinized on each step with the judges looking for a "bobble" or the slightest flaw that will downgrade the score.

There are different classes of pattern so that you can build your skill level step by step (an excellent concept). A lot of competitors don't necessarily aspire to compete at an international level, but, nonetheless, they enjoy the camaraderie of fellow modelers with similar interests and skill levels. They also enjoy rubbing shoulders with well-known competitors and hearing about the latest advances in the hobby!

THE PLANE

The rules for the aircraft are really quite simple; the prime focus is to determine a pilot's skill level, not who has the better-looking airplane. Like most countries, the U.S. has attempted to follow international rules, and this can be very important in maintaining competitiveness. The following rules apply to pattern competition aircraft:

• **Weight.** The maximum weight allowed is 5 kilograms, or 11 pounds.

• **Power.** Engines are currently limited to .60ci. for a single 2-stroke, 1.20ci for a 4-stroke and .80ci for a twin. Yes, there have been a couple of twins in competition!

•**Controls.** Basically, anything goes, but no autopilot or timed switches are allowed.

• **Noise.** Yes, there are limits on how much noise your model can make.

With today's technology, it's not difficult to comply with the threshold of 96dB at 3 meters.

F3A

F3A is a designation of the pattern-competition category, as assigned by the Federation Aeronautique Internationale (FAI)*. The FAI is a world aeromodeling association based in France. Pattern maneuvers are defined in both the AMA* handbook and the FAI manual. Remember, there is no need to be intimidated by the prospect of going to a pattern contest! You'll quickly find out that the welcome mat is always out for newcomers and that competition is highly addictive!

A GOOD START

What do you need to get started in pattern today? One thing is for sure: you don't need a Finesse to be competitive! A lot of good sport aircraft could be very competitive in the novice or sportsman classes.

To start, I recommend at least a .60 2-stroke plane that's simple, reliable and has "neutral stability" (it goes where you aim it). In contrast, a trainer has inherent stability (a tendency to fly upright, straight and level). Pattern maneuvers are tougher to fly with a trainer because you're constantly fighting against these built-in characteristics. Low-wing aircraft that are easy to fly (ask around) and have a fully symmetrical airfoil (the same shape on the wing's top and bottom) would really help the novice pattern pilot.

If you're not sure which plane to start with, ask your local hobby shop dealer; also, see what your club members suggest. There are so many options out there, but to help you out, here are a few suggestions:

• A Tiger 2 by Carl Goldberg Models* with a sport .40 engine is a good novice starting point.

• The new Tiger .60 with a sport .60 engine would be even better; it's very competitive and simple to set up. A basic 4-channel will do just fine for the first two competition classes noted in the sidebar, but you might want to spend a little more and purchase an intermediate-level programmable radio with a few bells and whistles, e.g., the Futaba 7 UAP. (This isn't required to be competitive.)

You may have noticed that I haven't mentioned 4-strokes. For good reason! Pound per pound and cubic inch per cubic inch, they're more expensive and less powerful. They also vibrate more and are less reliable, but I still think they're great. I own a few and use them regularly, but, for the first two classes of pattern, I strongly recommend that you stay away from them. As time goes on, you'll quickly see what the current "hot" setup is. You'll be well-informed and ready to make a good choice for the higher classes if you choose to do so. Like most of us, once bitten by this bug, your life may be changed forever!

RULES, RULES AND RULES

The AMA rule book contains a lot of valuable information on pattern flying. I highly recommend that you get one. It will put together the pieces and give you great insight into the pattern event. If you're looking for information on the international categories, you'll have to request an FAI Sporting Code.

Well, that should do it for this month; next month, we'll go into the specifics of IMAC and TOC, and touch further on fun-fly competition. Neat stuff! Till next month!

**Addresses are listed alphabetically in the Index of Manufacturers on page 153.* ■

RPM

DAVE GIERKE

REAL PERFORMANCE MEASUREMENT

BREAKING IN LAPPED AND RINGED-PISTON ENGINES

THE SCENE IS familiar: at the local flying field, the engine is fired up for the first time. The needle valve(s) and the idle are set, and the throttle transition is checked and adjusted by the resident instructor. That white-knuckle first flight is almost at hand. An anxious newcomer surveys his shiny new model and reflects on the many hours and dollars that were required to get to this moment.

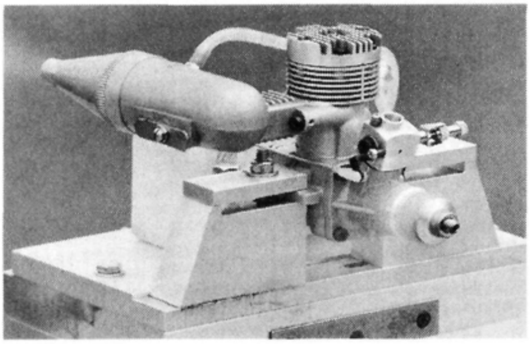
If it's lucky, a couple of tanks of fuel are run through the engine during the carburetor-adjusting operation. The instructor, of varied experience, is busy making sure that all the other details are correct before the fateful takeoff. Finally, the engine throttle is advanced to maximum power, and the event begins. The model breaks ground and climbs nose high for altitude. The pilot might be concentrating on needed trim corrections when it suddenly happens: *RRRRPPPP!* The engine quits!—a pilot's worst nightmare (other than reversed ailerons). The model is only 25 to 50 feet above the ground, nose high, with relatively low air speed. If the elevator stick isn't shoved forward immediately, the ship may experience a stall spin in which the consequences are usually detrimental to the equipment.

The Fox .40 R/C (no. 24095) is a great value with a lapped iron piston and steel cylinder sleeve. Break-in is critical.

If luck prevails, the model lands safely. Although the engine is still smoking and too hot to touch, reasons for its undesired performance are offered by all present. "This brand of fuel isn't any good." "Did you use an idle-bar glow plug?" "The prop's too large." "You need a pump." "They never could build an engine that works!" From the background, a timid voice is heard to say, "It sounded a bit lean to me; does it have much time on it?"

All of these theories and a variety of imaginative others could explain the engine's sudden stoppage but, in my opinion, the number-one cause of crashes owing to mechanical problems is *a lack of proper engine break-in.* Some say that they always achieve satisfactory break-in in the air with no difficulty. I will be the first to admit that this is possible, since I've done it myself when pressed for time. On the other hand, newcomers need to become familiar with their engines before flying them. The engine must be as close to 100 percent reliable as possible before you attempt to fly. There are too many other things to worry about without having to baby a balky, hot-running engine.

The following material is designed to convince you of the necessity and benefit of bench break-in. For those who routinely do it in the air, good luck!



PHOTOS BY DAVE GIERKE

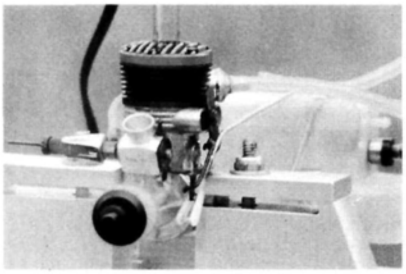
This Enya .60 has an aluminum piston fitted with a single compression ring operating in a steel cylinder sleeve. It required three hours of break-in, but now it's a great, reliable powerplant.

BREAK-IN: WHAT IS IT?

Peter G.F. Chinn, longtime engine-review columnist for *Model Airplane News,* defined engine break-in as "the process involved in aiding an engine's transition from a newly assembled conglomeration of assorted metal parts to an efficient, working whole. It means running the engine under carefully controlled conditions at the beginning of its life to avoid the risk of immediate damage and to help working surfaces to become properly smoothed and aligned for maximum mechanical efficiency and performance." This statement, made almost 30 years ago, still holds true today.

Engines with certain types of piston/sleeve combinations run at significantly higher temperatures when new, owing to the friction generated by various working surfaces. These types include:

- Lapped iron or steel pistons running in iron or steel cylinder sleeves, such as the Fox* .40 R/C (no. 24095).
- Ringed aluminum-alloy pistons running in steel or iron cylinder sleeves, such as the Enya* .60 XF4-G8 with a



This nostalgic K&B .45 R/C really has a bark without a muffler. The green head has an exhaust baffle as part of its throttle assembly. No mufflers here! (Lapped iron piston.)

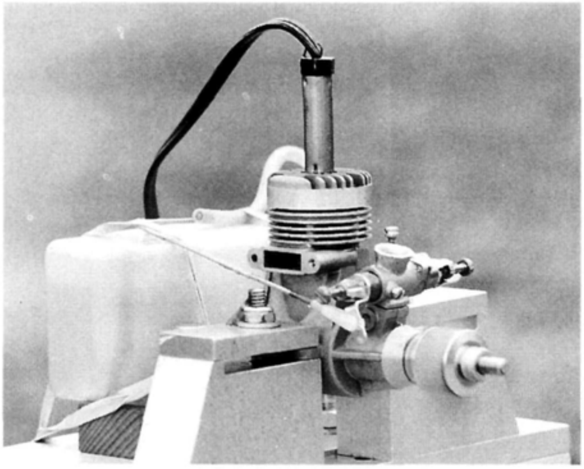
single, compression ring and the K&B* .40 R/C (no. 4011) with a single, no-tension ring.

Friction and heat generated by the interaction of microscopically rough surfaces is added to the heat of normal combustion. If the engine is pushed toward peak performance too quickly, elevated temperatures could result in catastrophic failure of one or more components, but the results are usually not that dramatic. Inferior break-in procedures generally produce worn parts that limit the engine's performance potential and running lifetime.

When the engine is running, we can't see what's happening inside, but here's a list of things that probably occur:

- Cool air/fuel mixture enters the cylinder on one or more sides of the piston with hot exhaust gases exiting on the other; unequal piston expansion and distortion is probable.
- Cylinder temperatures are greater above the ports (where combustion occurs). The cylinder expands more at the top than at the bottom, affecting the wear pattern between the piston and the cylinder.
- As the piston is being pushed away from the cylinder head by expanding high-pressure gases, the connecting rod forms an angle with the cylinder center line. This produces a side thrust (vector force) that generates a distorting load for the piston against the cylinder. This side load isn't nearly as great on the opposite wall for the return stroke because the force is minimal.
- If cylinder cooling is uneven, the aluminum-alloy jacket (crankcase) may distort the sleeve; this adversely affects the fit of the piston when the engine is running.

And we thought these were simple "toy" airplane engines! How much these factors affect an engine's performance is the subject of debate among experts. One thing is certain: you can't force these influencing factors to occur unless the engine is actually run—brought up to temperature and then allowed to cool—time after time.



The Fox .40 with its lapped iron piston and steel cylinder sleeve runs for the first time—very rich and 4-cycling. A new engine may require glow heat for the first few runs until it loosens up. Always wear eye and ear protectors when you run any engine on the test stand.

HEAT-CYCLING

By keeping the individual runs short and allowing the engine to cool completely, metal parts are allowed to heat-cycle. Some believe that molecular instabilities within the parts caused by manufacturing processes need final stress relief; this is accomplished by repeated heating and cooling within the engine itself.

What can be done to break in these special engines properly? In theory, it's simple: reduce the engine's temperature and flood it with lubrication. Let's take a closer look.

SAMPLE PROCEDURE

1 Start and operate the engine, 4-cycling, for about 1 minute. Perform this four to six times with cooling-off periods in between. (When you can hold the cylinder head without getting burned, it's ready for the next run.)

2 Run the engine for 3-minute periods, rich 4-cycling, as before. Cool completely between runs. Perform this eight to 12 times.

3 Start the engine. Lean the needle valve until it breaks into a rich 2-cycle. Listen to the engine carefully, and watch the tachometer if you have one. If it begins to slow down, quickly richen the needle; the engine is still too tight and needs more running. Revert to step no. 2 until it will hold a steady rpm at the leaner setting.

4 At this point, lean the engine to a fast 2-stroke setting. It should hold its setting without losing speed. If it still doesn't maintain rpm, richen the mixture and run through the process again. Always remember that break-in requires short runs during which cyclic heating and cooling occurs.

Engine break-in is a time-consuming process. If it's done properly, you'll be rewarded with a powerful, consistent unit that will last for years.

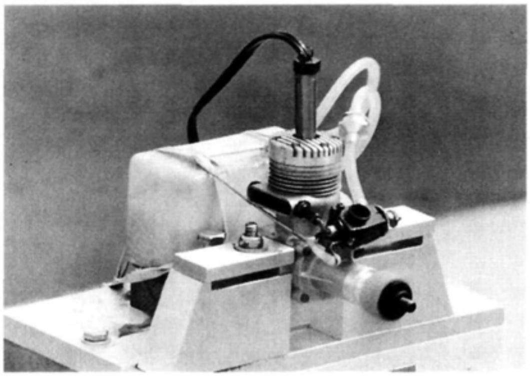
TEMPERATURE

For a given cylinder displacement and rpm, 2-stroke-cycle engines operate at higher temperatures than 4-stroke types. Why? Four-stroke-cycle engines require two revolutions of the crankshaft to com-

plete their cycle. Therefore, their power, or expansion operation, happens every other revolution. Two-stroke-cycle engines experience a power event with each revolution. Since 2-stroke engines produce combustion twice as often as their 4-stroke counterparts, you might expect twice as much heat to be generated. Actually, because of breathing limitations, the 2-stroke design burns less than the optimum mass of air/fuel per cycle compared with the 4-stroke unit. It still produces at least 50 percent more heat than the 4-stroke design, however.

THE ENGINE: AN AIR PUMP

An engine's capability to produce power is fundamentally dependent on its capability to ingest air. A partial vacuum is generated in the crankcase when the piston moves away from the crankshaft and toward the head. When the inlet valve opens, the relatively high pressure of the atmosphere pushes air through the carburetor and into the crankcase. In the carburetor, fuel is added to the air in the correct proportion for combustion to take place.



Here's an early '70s K&B .40 with an aluminum piston and iron dykes-type ring running in a steel cylinder sleeve. After almost 30 years of production, this engine series is still going strong.

COMBUSTION RANGE

For any hydrocarbon fuel, there's a range of air/fuel ratios in which combustion will occur. If the needle valve is leaned too much, the amount of fuel available to the air will produce greatly elevated and destructive combustion temperatures. If leaned further, the air/fuel ratio will increase to a point at which the engine stops firing. Misfiring also occurs at the opposite end of the air/fuel ratio spectrum when too much fuel is added to the available air (rich).

"4-CYCLING" IN A 2-STROKE-CYCLE ENGINE

Have you ever heard someone say, "Richen the needle valve until it 4-cycles," or "Listen to that engine 4-cycle; it's really rich"? Occasionally, you may hear someone suggest a break-in strategy such as, "Run it rich for half an hour, 4-cycling." This might seem like a natural term to use for 4-stroke-cycle engines, but we're talking about 2-strokers!

Listening to a 2-stroke engine "4-cycle," you can't help but notice that the exhaust frequency (pitch) is lower, just as if it's firing on every other cycle. Surprise! That's exactly what it's doing. This is the key to keeping the engine cool and well-lubricated during break-in.

How can our 2-stroke engine fire on every other cycle? Sound like science fiction? Read on!

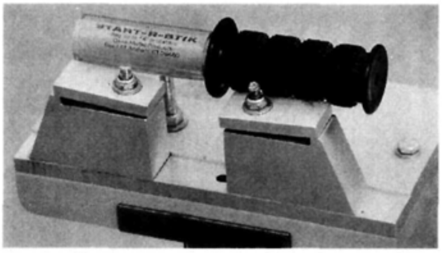
THE PROCESS

If an engine's fuel is richened to just inside the rich limit of the combustion range, it will begin to misfire every other cycle. Why?

As the combustion process takes place, not all the exhaust gases are scavenged (flushed) out of the cylinder. This is normal. However, as the next air/fuel charge is moved into the cylinder from the crankcase and through the cylinder's transfer port(s), it is mixed with leftover exhaust gases. Waste gases impede the oxygen molecules' access to fuel molecules just enough to move the mixture ratio outside the combustion range. The engine misfires!

The unburned mixture does a good job of purging the cylinder, so the next fresh air/fuel charge enters a relatively unpolluted chamber, where it is again within the combustible range and ignites.

The engine alternately fires and misfires in this fashion, forming the familiar 4-cycling pattern. Reducing the number of firing operations by half through 4-cycling drastically reduces the engine's temperature. Heat is removed by conduction to the unburned liquid fuel, and more is taken away by its vaporization.



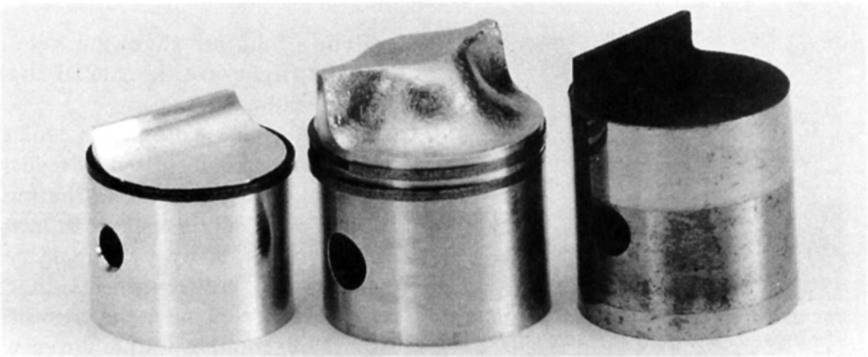
Davis Model Products* offers a man-size chicken stick with a rubber grip handle. Available in regular (for props of up to 14 inches) and large (for props over 16 inches), the starting tool feels very comfortable when starting new or vintage engines. Also pictured is the fabulous Sheldon Engineering* all-aluminum test stand—a must for the serious engine experimenter.

The rich needle-valve setting, coupled with firing on every other cycle, ensures that an abundant supply of lubricant passes through the engine at all times. Cool and oily—that's the secret to breaking in non-ABC-type engines!

LUBRICATION

As described, 4-cycling provides not only cooling but also enhanced lubrication when you're breaking in non-ABC-type engines. High percentages of lube, between 24 and 30 percent, are also recommended to ensure that internal parts

The aluminum piston with its iron compression ring, connecting rod and wristpin assembly rests on its steel cylinder sleeve. This unit was removed from a new Webra* Silverline 10cc (.61ci) cross-flow scavenged engine.



Examples of piston/piston ring types. Left: an aluminum piston with a dykes-type (no tension) cast-iron ring from a K&B .40 R/C (no. 4011). Center: the piston with the high dome is made of aluminum and contains two cast-iron compression rings. It's from a vintage McCoy* Red Head .60 racing engine of the early '60s. Modern ringed engines use only one compression ring to reduce frictional losses. Right: a lapped iron unit from the spark-ignition era. The Anderson Spitfire piston was durable, but heavy, which limited rpm and horsepower. Three to five hours of careful break-in were usually required.

will be liberally coated at all times. Fox recommends that only castor-oil lubricant be used with their lapped iron piston and steel liner engines. They claim that castor oil is "absorbed into the iron and seasons it much as a new cast-iron skillet is seasoned to prevent sticking." Fox says that synthetic lubricants won't do this. I'll have more to say about this later.

HOW MUCH TIME DOES IT TAKE?

So how much time does it take for a complete break-in? As you might expect, break-in time varies for each engine type and manufacturer. From the 1930s through the 1950s, manufacturers recommended 3 to 5 hours on the bench before all-out operation. These were iron and steel piston and sleeve (lapped) units.

Back in the old, old days (1930s and '40s), many modelers attempted to shorten the lapped unit's break-in period by motoring the engine. This consisted of mounting the engine on a drill press or a metal lathe where it was turned over for several hours with lots of lubricating oil, which also acted as a coolant. This procedure didn't help the piston/cylinder fit because the combustion temperatures and pressures were absent, but the connecting rod and wristpin holes were usually polished up.

In the old days ('50s and '60s), some enthusiasts ran their new engines continuously on a large supply of fuel. The rich needle-valve setting kept the engine cool, and they assumed that after several hours, the break-in was complete. Tests have shown that little, if any, break-in occurs unless the engine is heated to normal operating temperatures and then allowed to cool. As mentioned earlier, heat-cycling does the job.

Engine designers have used every technique to minimize the effects of heat-cycling on engine performance. The newer ABC-type engines usually require less than an hour of break-in, which is accomplished much differently. This technology literally comes at a price—a larger capital investment at the hobby shop. They also have their own set of operating procedures to maintain maximum performance levels (see "Real Performance Measurement," January '94 issue). All other types require careful break-in over prolonged periods.

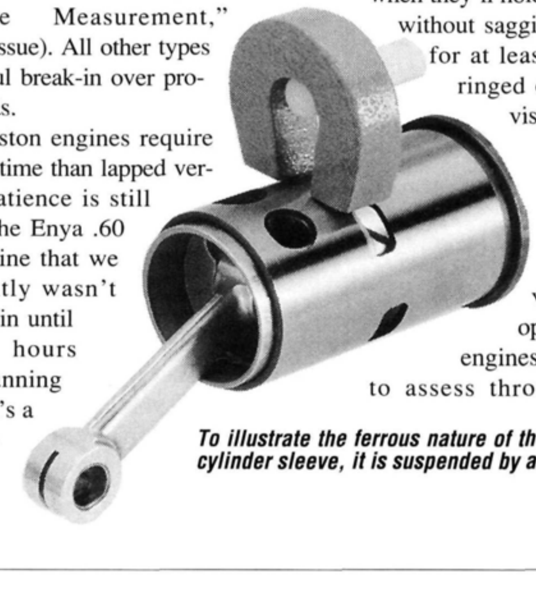
Ringed-piston engines require less break-in time than lapped versions, but patience is still necessary. The Enya .60 XF4-G8 engine that we tested recently wasn't fully broken in until after three hours of careful running time. Now, it's a tremendous engine, exhibiting great compression and high torque. The K&B .40 (zero-tension ring) R/C engine is another good example. K&B recommends a minimum of one hour of break-in. My experience suggests that two to three hours are required if you want a top-performing, long-lasting unit. Fox recommends running the engine "rich for the first few tanks of fuel." Mine still isn't fully broken in after four hours!

I find it curious that manufacturers' manuals downplay the significance of the break-in period! Do they think that today's breed of sportsmen won't buy their products if they require bench preparation time? I think that just the opposite is true: the majority of modelers want to do the job correctly; after all, it's their hobby, and engines are expensive. But someone has to tell them and demonstrate how to do it correctly. I haven't read a single owner's manual that pays more than cursory attention to the issue.

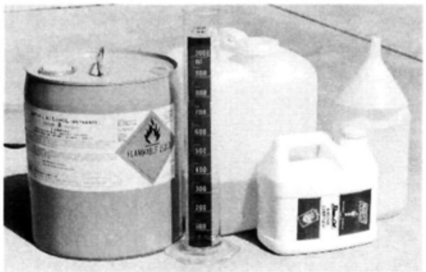
WHEN IS THE ENGINE BROKEN IN?

As you can see, time alone isn't an indicator of when break-in is complete. Break-in requires short running periods during which the needle valve is occasionally leaned to a point at which the engine comes up to speed and temperature and is then immediately richened to a 4-cycling, cooling mode.

Rule of thumb suggests that lapped and ringed-piston engines are broken in when they'll hold a peak rpm setting without sagging (slowing down) for at least 30 seconds. For ringed engines, there is a visible sign that break-in is probably complete: the machine marks disappear from the visible edge of the ring as viewed from the open exhaust. Lapped engines are more difficult to assess through observation,



To illustrate the ferrous nature of the Webra Silverline's cylinder sleeve, it is suspended by a horseshoe magnet.



The author mixes his own fuel for all tests. The 5-gallon can (left) is methanol; the tall, glass, 1,000ml graduated cylinder is used for mixing; the plastic 5-gallon can (third from left) contains nitromethane; the short gallon jug contains castor oil; and the standard gallon container (far right) contains Klotz KL-200 synthetic oil. All these fuel ingredients are available from Klotz. Many fuel companies will custom mix break-in fuel to your specifications, and others already have the desired blend as part of their standard products.

although some people are guided by the color and uniformity of wear on the piston.

SAMPLE BREAK-IN

• **Log**. Keep an accurate record (run times; notes).

• **Fuel**. Low nitromethane content (5 to 10 percent) with 24 to 30 percent lubricant. I strongly suggest that you use castor oil for at least half this percentage. If a lean run occurs, castor oil offers excellent protection against mechanical damage to the piston and cylinder. The minor inconvenience of having to disassemble the engine occasionally for cleaning is a small price to pay for the added security castor oil provides over straight synthetics. It also takes more effort to remove from the model at the end of the day, but to any modeler who enjoys doing it right, the price is minimal. Try Dawn dishwashing detergent diluted with water in a spray bottle; it does a great job of cutting the castor-oil goo. I also highly recommend Klotz* KL-200 synthetic oil for the other half of the lube package.

• **Muffler**. The engine will run cooler if the muffler is removed during break-in; however, you'll lose your solid needle-setting and muffler-pressure advantage, and the neighbors won't appreciate the additional racket, so leave it on.

• **Prop**. Smaller than the recommended flight size, i.e., 12x6 flight, 11x6 break-in.

Note: the engine will operate cooler if the shaft speed is increased by reducing the load (prop size). This happens because cylinder pressures are decreased at higher rpm. Known as break mean effective pressure (bmep), it's directly responsible for torque at the crankshaft. Any representative torque curve will show the cylinder pressure tendency, which drops off as rpm increase. The gas laws tell us that as pressure decreases, so does temperature.

FLYING

When the engine is mounted in the model and ready for flight, remember one more thing: never set the needle valve to its maximum rpm speed and then fly. Always richen the needle until it loses a minimum of several hundred rpm. With my muffler-equipped .60-size engines, I make sure to back them off 300rpm to the rich side. When you point the nose up, as in a loop, the carburetor mixture may lean out. The rich initial setting prevents the engine from running lean and hot, averting damage to the unit if it isn't completely broken-in. Experiment with the richness required to maintain a non-lean, nose-high running environment. Of course, there are exceptions to every rule, depending on individual setups, such as the use of tuned pipes, fuel pumps and high-nitro fuels. We'll look at some of these as time and space permit. In the meantime, don't let the guy at the flying field tell you he can break in his new engine just as well in the airplane as you can on the test stand. He'll be the first to whine about the engine not pulling when he puts the nose up, or how he has only had the engine a month, and "already the piston and connecting rod are worn-out." Try not to snicker while pointing him in the direction of the nearest hobby shop.

**Addresses are listed alphabetically in the Index of Manufacturers on page 137.* ■

MOSKITO

(Continued from page 75)

illustrate the use of both four and five servos for the helicopter's control functions, so you can use either a helicopter radio or a standard airplane radio. This option allows R/C pilots to get into helicopters without purchasing a heli-specific radio. I installed a JR X-388S radio and a JR-130 gyro.

I like this setup's flexibility. The instructions show two locations for the gyro, and I chose to install it behind the main shaft. Finishing the radio installation, I mounted the receiver, the battery and the amplifier for the gyro at the front of the frames. To protect it, the radio is mounted inside the frames.

CANOPY & STABILIZERS

The Moskito sports a one-piece, plastic canopy that includes a molded pilot figure. The canopy can be used in two configurations: open with a small windscreen and an accessory control arm (similar to an autogyro's setup); or enclosed with a full-coverage windscreen (more typical of helicopters marketed in the U.S.). I built the more enclosed canopy. Use six self-tapping screws and washers to install the windscreen. This vibration-resistant installation is very solid.

I painted the pilot figure with flat enamel paints. Mask off and paint the canopy and the vertical and horizontal stabilizers (I used Great Planes* red and yellow Lustercote). To protect the enamel from glow fuel, after the paint has dried, seal the canopy and the pilot figure with a coat of clear urethane.

SETUP

Set up the Moskito by installing a metal spacer gauge between the swashplate and the upper frame. Then adjust the elevator pushrods and the aileron pushrods to center throw position on the servo, and set the bellcranks at 90 degrees. From this setting, you can set the blades at the prescribed +5 degrees of incidence.

CONCLUSION

Robbe and Schlüter have themselves a winner! The Moskito is the first helicopter I've seen that I can honestly say can be a trainer one minute and a hot-dogger the next. It's truly an amazing design that seems to have no flaws. Its price is less than those of the present crop of .30 helicopters, and it has the features of most .60 helicopters. I've put my .30 heli away and will be flying the Moskito from now on.... ■

**Addresses are listed alphabetically in the Index of Manufacturers on page 137.*

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SALE—kits: wood, plastic; ignition engines; parts and mags (pre-1965). Specify needs. Send SASE and 60 cents for list. Leonard Roberts, 3819 Lydon Ln., Moosic, PA 18507; (717) 961-2357. [12/94]

WANTED: built or partially built Ercoupes, Cessna 150, 152, 172, 182, Grumman American Tiger (AA5), American Yankee (AA1), or Mooney M-10 Cadet. Glen Mills, P.O. Box 3393, Mission Viejo, CA 92690; (714) 768-0585. [11/94]

PLANS ENLARGED. Scanning/plotting services; model designer's computer software; free information. Concept, P.O. Box 669E, Poway, CA 92074-0669; (619) 486-2464.

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GIANT-SCALE PLANS by Hostetler. Send SASE to Wendell Hostetler's Plans, 1041 B Heatherwood, Orrville, OH 44667. [11/94]

ENGINES: IGNITION, GLOW, DIESEL—new, used, collectors, runners. Sell, trade, buy. Send $3 for huge list to Rob Eierman, 504 Las Posas, Ridgecrest, CA 93555; (619) 375-5537. [11/94]

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MODEL MOTORS WANTED—Most types, 1970 and earlier. Cash or trade. T. Crouss, 100 Smyrna, West Springfield, MA 01089. [9/94]

ANTIQUE IGNITION engine parts: excellent reproductions, fuel tanks, points, timers, coils, needle valves, gaskets, etc. Champion spark plugs. Catalogue—$5 (intl. airmail—$7). Aero-Electric, 1301 W. Lafayette St., Sturgis, MI 49091. [2/95]

WANTED: ignition model engines 1930s to 1950s, especially Elf, Baby Cyclone, Brown Jr., Ohlsson Custom and Gold Seal. Also model racecars, any parts, spark plugs, etc.; Woody Bartelt, 1301 W. Lafayette St., Sturgis, MI 49091; (616) 665-9693, or (800) 982-5464. [2/95]

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MAGAZINE BACK ISSUES—*Flying Aces, Model Airplane News, Air Trails*, 1930s and '40s. FM, RCM and more. Send SASE for list to Carolyn Gierke, 1276 Ransom Rd., Lancaster, NY 14086. [9/94]

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GERMAN AIRCRAFT WW II—handbooks, service part lists, instruction manuals. List—$2. Udo E Hafner, Eugen-Bolz-Str. 15, D-71636 Ludwigsburg, Germany. [11/94]

WW I PLANS—Peanut to 100 inches. Send $2 for illustrated catalogue to Clark Smiley, 23 Riverbend Rd., Newmarket, NH 03857. [3/95]

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BOOKS! "Tailless Tale"—tailless aircraft for modelers; $38. "Structural Dimensioning of Radioguided Aeromodels"—building *strong and light; $18. "On the Wing...the book"—tailless R/C* sailplanes; $28. Orders or information: B2 Streamlines, Dept. A, P.O. Box 976, Olalla, WA 98359. [9/94]

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OLD MODEL MAGAZINES. SASE for list. Dave Bessel, P.O. Box 669, Poway, CA 92074.

NEW ZEALAND AERO PRODUCTS. Scale plans: Agwagon, Pawnee, Pawnee Brave, Airtruk/Skyfarmer, Fletcher FU-24, Aerobat, Hall's Springfield Bulldog, Typhoon, DC-3/C-47, Fairchild PT-19/Fleet PT-26 and more. Epoxy fiberglass parts, hardware packs, timber packs, color photo packs available. Free documentation with plans. Fiberglass kit sets: P-51D Mustang, PBY Catalina, Focke Wulf 190, Bushby Midget Mustang. Catalogue/price list: $5 (U.S.); Visa/MC. 34 Ward Parade, Stirling Point, Bluff, New Zealand. Phone/fax-032128192.

MOLD-MAKING/CASTING GUIDEBOOKS. Complete techniques and sources for rubbers, plastics, resins, metals and more. Further information: Castech-A7, Box 16586, Memphis, TN 38186-0586. [9/94]

ENGINES FOR SALE: new, used, early and late glows. Some with carbs and mufflers. SASE for list. Joel Balsam, 4 Pickwick Hill Dr., Huntington Station, New York, NY 11746-1241. [9/94]

JET ENGINES—pulsejets, Jet-X, Turbonique. Monthly newsletter $17/yr; $25 international; single issue $2. Catalogue $5. DOYLE-JET, P.O. Box 60311-A, Houston, TX 77205; (713) 443-3409. [12/94]

PIT-SAFE SERVO DRIVER—Three models to choose from. Perfect for field or bench servo set-up. Servo reverse/retract switch standard. Starting at $18.95. For more info., write: Bouk R/C, 25089 Jutland Dr., Hemet, CA 92544. [9/94]

PAYING $50 EACH FOR FOLLOWING toy metal outboard boat motors: Mercury, Johnson, Oliver, Evinrude, Scott-Atwater, Gale. $60 each if with box. Richard Gronowski, 140 N. Garfield Ave., Traverse City, MI 49684; (616) 941-2111. [10/94]

MAGAZINE COLLECTION. "Air Trails"—Nov. 1935 through Feb. 1950. "Model Airplane News"—June 1939 through Nov. 1944, plus several pre-1939 issues, and "Air Progress Annuals" 1938 through 1943. All in good condition, best offer. Also for sale: new Cox .35 glow engine, early '60s vintage. Don Caulford, 29 Fallingbrook Dr., Scarborough, Ontario, Canada M1N 1B3. [9/94]

ULTRALIGHT AIRCRAFT. New publication has plenty of information, pictures and stories on this exciting flying sport. Buy, sell, trade and kit-built aircraft. You can learn to fly the real thing. Fixed wing, powered parachutes, rotor, balloons and blimps. Sample issue $3. Annual subscription $36. Introductory offer of only $24. "Ultraflight Magazine," 12545 70th Street North, Largo, Fl 34643-3025. [10/94]

NOW ON VHS! Detroit's 1949 Plymouth International Model Airplane Meet. Terrific color-sound. Mastered from 16mm "Hollywood"-style production. Tape features F/F, C/L, indoor action, awards ceremony. Portions are unintentionally hilarious. $19 includes postage and insurance. C.L. Pattie, 12140 Hiawatha, Shelby Township, MI 48315; (810) 781-6394. [10/94]

AIRSHIPS (MAN): Technical, history, tapes, collectibles. 522 E. Vine, Box 213, W. Covina, CA 91790. [2/95]

MODEL GRAPHICS/VINYL LETTERING. Introducing new 20-page *instructional catalogue and model decorating guide. Special offer:* any combination of 10, 2-inch letters or numbers, custom-cut and ready to install, with catalogue—$4.95. Graphics A.M.P. Inc., 42a Nancy St., W. Babylon, NY 11704; (516) 253-2702. [2/95]

WANTED: Old wood kits, magazines, WW II IDs and Mfgrs. models. Bill Fornwalt, 103 Dartmouth Ave., Johnstown, PA 15905. [2/95]

WANTED TO BUY Kraft Single Stick Systems. Good prices. For information: Luis A. Barranco, M.D., P.O. Box 7682, Ponce, P.R.; (809) 842-7325. [12/94]

R/C SKYDIVING—illustrated catalogue: $1. R/C Skydivers, Box 662N, St. Croix Falls, WI 54024. [2/95]

YELLOW AIRCRAFT, Blue Angel # 6, twin O.S. 91s, dual in-flights, variable geometry chrome cones, brakes, etc. Asking price $10,000. Two other paint schemes to choose from. Call for prices. Bob Fiorenze; (407) 327-6353. [10/94]

TOY METAL OUTBOARD BOAT MOTORS WANTED: Oliver, Gale, Mercury, Sea Fury Twin, Johnson, Scott, Evinrude, paying $60 each. Also want toy wooden boats, tin windup toy cars, motorcycles, robots, cereal premiums, Any Thing Sky King, Capt. Midnight, Jimmy Allen, Tom Mix, etc. Aviation-related comic books from the 1930s, '40s, '50's. Richard Gronowski, 140 N. Garfield Ave., Traverse City, MI 49684; (616) 941-2111. [9/94]

MODELER'S SCROLL SAW. Build your own fine-cut scroll saw. Inexpensive. Powered by unaltered saber saw. Plans $7. Crafty Creations, Box 222, Burlington, KS 66839. [11/94]

ANTIQUE IGNITION-GLOW PARTS CATALOGUE, ½-inch thick, timers, needle valves, cylinder heads, pistons, points, tanks, spark plugs, race-car parts. Engines: 1/2A's, Baby Cyclones, McCoys, Phantoms, etc. $8 postpaid (U.S.); $20 foreign, Chris Rossbach, R.D. 1, Queensboro Manor, Box 390, Gloversville, N.Y. 12078. [2/95]

CUSTOM-BUILT, LIGHTWEIGHT (350 lb.) 7-foot trailer with removable canopy and storage area for accessories. Perfect transportation for models regardless of distance. $1995. Gene Fierce, N. 6015 Elm St., Spokane, WA 99205; (509) 325-1045. [10/94]

WANTED—United States and Canada automobile license tags. Have Delaware, Illinois, Kentucky, Arkansas, Pennsylvania, Florida, Indiana, Ohio. Will reimburse reasonable expense. Need your help! Thanks. Nicholas R. Tarbuck, 46 Nebraska Ave. N.E., Ft. Walton Beach, FL 32548-5026. [10/94]

SODA-CAN AIRPLANES replica biplane detail plans with photos $7.50 PPD, Early's Craft, 15069 Valley Blvd. SP 26, Fontana, CA 92335. [8/95]

NOSE ART T-SHIRTS: 100% cotton. Order early for Xmas. Designs of Memphis Belle, Miss Behavin' or Snack Time. $15.95 each M-XXL. $2 shipping. Many more available. Send for catalogue at $1.95, or free with order. Allow 4 to 6 weeks. Send check or money order to: Flight Line Design, P.O. Box 84, Orange, CA 92666. [11/94]

MODEL AIRPLANE NEWS

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Completa linha de aeromodelos, carros, barcose helicopteros radio controlados, plastimodelismo, componentes e servicos. Importacao direta.
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PRODUCT NEWS

MARK'S MODEL BUILDING
Extra 300

Constructed of balsa and plywood, the Extra 300 is available custom-built, framed up, or completely finished. Specifications: wingspan—72 inches; wing area—900 square inches; ready-to-fly weight—9 to 10 pounds; power—.90 to 1.08 2-stroke, or 1.20 4-stroke. Mark will custom-build any model airplane kit; call for price information.

Mark's Model Building, 133 Bayard St., Kane, PA 16735; (814) 837-9435.

AERO COSMETICS® INC.
WashWax

WashWax is available in two formulas—WashWax 777 and WashWax 787. Both will clean, wax and form a protective barrier against dirt, moisture and ultraviolet rays. Neither needs water, and both can be used on wet surfaces. Nonabrasive WashWax 777 is safe for all surfaces, including windows. WashWax 787 conquers tough grime, yet it won't corrode. Prices given are for 32 ounces (spray bottle) and 1 gallon.

Prices—$7.95/$22.95 (WashWax 777); $8.95/$24.95 (WashWax 787).

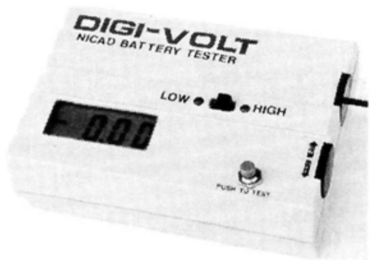
Aero Cosmetics® Inc., P.O. Box 460025, San Antonio, TX 78246; (210) 344-7921; to order, call (800) 727-0747, or fax (800) 727-7209.

TOP FLITE
AT-6 Texan

This 1/7-scale AT-6 Texan is easy to build and fly and includes: a durable, injection-molded ABS cowl; a vacuum-formed oil cooler and carburetor intake scoops; an adjustable engine mount; and a vacuum-formed ABS exhaust stack. The large, vacuum-formed "greenhouse" canopy has molded-in frame detail and all parts and decals needed to create a realistic two-seater cockpit. Specifications: wingspan—69.4 inches; wing area—713 square inches; weight—7½ to 10 pounds; wing loading—24 to 32 ounces per square foot; length—49¼ inches; radio—4- to 6-channel; engine—.61 to .91 2-stroke, or .91 to 1.20 4-stroke.

Kit no.—TOPA0130; **list price**—$249.99.

Great Planes Model Distributors Co., P.O. Box 9021; Champaign, IL 61826-9021; (217) 398-6300.



RC IGNITION
Digi-Volt Ni-Cd Battery Tester

Powered by a 9V battery, the Digi-Volt can be used to test 3- to 14-cell battery packs, and it can also be used as a voltmeter that can read from 0 to 19.99 volts. It comes in an attractive 1½x3½x5-inch case.

Price—$30.

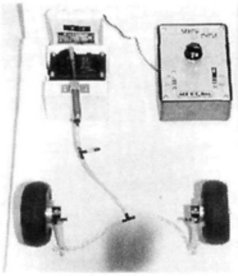
Ignition, 16845 N. 29th Ave., #1434, Phoenix, AZ 85027; (602) 582-1053.

J'TEC
Mufflers

J'Tec offers mufflers and pre-heater smoke coils for the German-made 3W-70B2 twin-cylinder engine. Made of cast aluminum, the mufflers can be bolted directly onto each cylinder, and mounting bolts and flexible metal exhaust-pipe extensions are included.

Part nos.—JT-3W4.2 (mufflers), 3W4PHC (pre-heater smoke coils); **prices**—$115/set, $15/set.

J'Tec, 164 School St., Daly City, CA 94014; (415) 756-3400; or order from Desert Models, (602) 722-0607.



FIORENZE HOBBY CENTER
Hydraulic Brake System

This unique proportional hydraulic brake system has a master cylinder, a drill guide and all the necessary hardware. Using fluid instead of air, it doesn't require an air bottle, a filling valve, a two-way valve, or an extra servo. You actuate the system by hooking it to the elevator servo (when using down-elevator), or by adding an extra servo to the receiver's auxiliary channel. The hubs fit any 5/32-inch landing gear on any high-wing trainer, sport, pattern, or ducted-fan airplane.

List price—$125.

Fiorenze Hobby Center Inc., 420 West S.R. 434, Winter Springs, FL 32708; (407) 327-6353.

PRODUCT NEWS

CUSTOM ELECTRONICS
Servo Analyzer

The Servo Analyzer can help you evaluate your servos and linkages and determine the right battery capacity for your airplane. It's a current meter that can be plugged into your radio system between your receiver and a servo, and it will tell you how hard the servo is working.

Prices—$19.95 (with two installed connectors), $14.95 (without connectors).

Custom Electronics, RR 1, Box 123B, Higginsville, MO 64037; (816) 584-6284; fax (816) 584-6285.

ALTECH MARKETING
Beech Musketeer

This giant-scale ARC (almost ready to cover) kit includes a laminated-wood fuselage, sheeted foam-core wings, airfoil-shaped tail surfaces, a cowl, fixed main gear and a steerable nose gear. Specifications: wingspan—96 inches; wing area—1,248 square inches; wing chord—13 inches; length—71¾ inches; power—Enya 120-4C.

Kit no.—IE700; **list price**—$398.98.

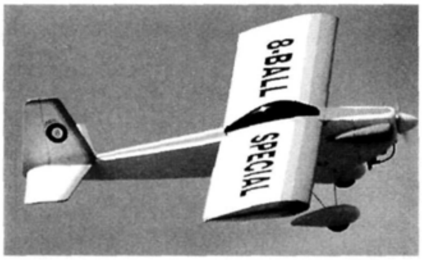
Altech Marketing, P.O. Box 391, Edison, NJ 08818-0391; (908) 248-8738.

R&R DISTRIBUTORS
MAT Grumman F8F2 Bearcat

This ⅕-scale, limited-edition kit has an epoxy/glass fuselage and pre-sheeted surfaces, and its details include panel lines, rivets, hatches and retractable landing gear. Three-views are provided. Specifications: wingspan—87 inches; length—67½ inches; weight—24 to 30 pounds; engine required—4.2 to 7.4ci.

Prices—$1,779.95; $109.95 (optional wooden parts kit).

R&R Distributors, P.O. Box 144, Wood Ridge, NJ 07075; (800) 752-1650; (201) 804-0077; fax (201) 804-8068.



REID'S QUALITY MODEL PRODUCTS
8-Ball Special

This quick-to-build kit includes: foam wing-cores; hand-cut, lite-ply fuselage sides; plywood and balsa formers; fuselage sheeting; bent-aluminum landing gear; a clear canopy; and a fiberglass cowl. The 8-Ball Special is very aerobatic and capable of slow flight. Specifications: wingspan—85 inches; wing area—1,360 square inches; length—63 inches; weight—17½ pounds; power—G38/Q42 (or similar).

List prices—$249.95, $199.95 (special introductory price), plus $10 S&H; NY residents add 7 percent sales tax.

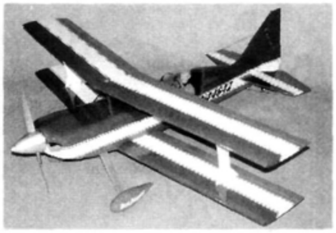
Reid's Quality Model Products, 16 Main St., Phelps, NY 14532; (315) 548-3779; fax (315) 548-4099.

HOBBYTECH
Maximum Airspeed Indicator

This highly accurate indicator is designed to measure your aircraft's maximum air speed—up to 250mph. Weighing only 3.2 ounces, it's easy to remove from your plane. After a flight, plug your voltmeter (adapter included) into the control panel and take the reading. A conversion slide chart gives the speed in knots and miles per hour.

List price—$149.95.

Hobbytech, 34 Joslyn Dr., Elgin, IL 60120; (708) 695-5903; fax (708) 837-6235.



DIRECT CONNECTION R/C
Ultimate 10-300S ARC

This almost-ready-to-cover kit features hand-crafted, sanded, all-balsa construction with composite landing gear and a fiberglass cowl and wheel pants. Specifications: wingspan—56 inches; wing area—1,065 square inches; length—60 inches; weight—8 to 9½ pounds; engine—.60 to .90 2-stroke, or .90 to 1.5 4-stroke.

List price—$349.99.

Direct Connection R/C, 562 W. Schrock Rd., Westerville, OH 43081; (614) 899-6313.

Descriptions of products appearing in these pages were derived from press releases by the manufacturers and/or their advertising agencies. The information given here does not constitute endorsement by **Model Airplane News**, nor does it guarantee product performance. When writing to the manufacturer about any product described here, be sure to mention that you read about it in **Model Airplane News**. **Manufacturers!** To have your products featured here, address the press releases to **Model Airplane News,** attention: Julie Soriano.

CLUB OF THE MONTH

HUMMING BIRD FLYING CLUB
27 Graham Heights, Kingston 8
Jamaica, W.I.

We seldom receive newsletters from foreign aeromodeling clubs, and when we do, we're always thrilled to learn that *Model Airplane News* is so widely read. This month's winner—the Humming Bird Flying Club—is on a Caribbean island paradise—Jamaica, to be exact. In the April '94 issue of its newsletter, *Western Views*, editor Wayne Matthews boasts that, for the number of competitions it organizes, the club is second to none. The one-and-a-half-year-old club annually hosts five well-attended air shows that are sponsored by major corporations such as Western Union and Kentucky Fried Chicken.

To quote Wayne: "Modeling is alive and well and progressing rapidly in Jamaica." The club's 36 members fly a wide range of airplanes—from trainers to ducted-fan jets—and they have already organized seven competitions.

This well-written newsletter offers flying tips and features columns such as "Scale Aerobatics," "Giant Scale Corner" and "Jet Trails." There's also a "Name the Plane" drawing, a "Tip of the Month" and a "Plane of the Month."

In "Racing Scene," there's news that "The word is going around that the racing fraternity plans to study Spanish" to understand the philosophy and techniques of the rival Cuban Assassins team, which is known for its winning record. (Some say this is untrue and that the Assassins' days of winning are numbered anyway!)

It is interesting to note that the words under the club's logo read, "Dedicated to the safe building, flying and enjoyment of all types of model aircraft"—a golden rule that all modelers should follow.

We wish the Humming Bird Flying Club continued success in the R/C community. For its uniqueness and for giving us a glimpse of modeling in another part of the world, we award the club two complimentary subscriptions to *Model Airplane News*. ■

INDEX OF MANUFACTURERS

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Airtronics Inc., *11 Autry, Irvine, CA 92718; (704) 830-8769.*

AMA (Academy of Model Aeronautics), *5151 East Memorial Dr., Muncie, IN 47302; (317) 287-1256.*

AMP Graphics, *36 Park St., Blue Point, NY 11715; (516) 363-5205.*

Anabatic Products, *411 Beach Park Blvd., Foster City, CA 94404; (800) 573-9373.*

Bob Violett Models, *170 State Rd. 419, Winter Springs, FL 32708; (407) 327-6333.*

Cannon R/C, *2828 Cochran St., Ste. 281, Simi Valley, CA 93065.*

Carl Goldberg Models, *4734 W. Chicago Ave., Chicago, IL 60651.*

Clancy Aviation, *219 W. Second Ave., Mesa, AZ 85210. (602) 649-1534.*

Cox Hobbies, *350 W. Rincon St., Corona, CA 91720.*

Davis Diesel Development, *P.O. Box 141, Milford, CT 06460; (203) 877-1670.*

Davis Model Products; *distributed by Davis Diesel Development (see address above).*

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Enya; *distributed by Altech Marketing, P.O. Box 391, Edison, NJ 08818-0391.*

FAI, *10-12, Rue du Capitaine Menard, 75015 Paris, France.*

Fox Mfg. Co., *5305 Towson Ave., Ft. Smith, AR 72901.*

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Great Planes Model Distributors, *P.O. Box 9021, Champaign, IL 61826-9021; (217) 398-6300.*

Hitec/RCD, *10729 Wheatlands Ave., Ste. C, Santee, CA 92071; (619) 258-4940.*

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JR; *distributed by Horizon Hobby Distributors Inc., 4105 Fieldstone, Champaign, IL 61821; (217) 355-9511.*

K&B Mfg. Inc., *2100 College Dr., Lake Havasu City, AZ 86403.*

K&S Engineering, *6917 W. 59th St., Chicago, IL 60638; (312) 586-8503.*

Klotz Oil, *John Klotz, P.O. Box 11343, Ft. Wayne, IN 46857.*

Litco Systems, *P.O. Box 90, East Hanover, NJ 07936.*

McCoy Racing, *1778 Albright Ave., Upland, CA 91786.*

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Northeast Sailplane Products, *16 Kirby Ln., Williston, VT 05495.*

O.S.; *distributed by Great Planes Model Distributors (see address above).*

Pacer Technology, *9420 Santa Anita Ave., Rancho Cucamonga, CA 91730.*

Perma-Grit Products, *1302 Berwin Ave., Dayton, OH 45429.*

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Quality Fiberglass, *2530 Zebwarren Rd., Cookeville, TN 38501; (615) 526-4770.*

Radio Shack, *500 One Tandy Center, Ft. Worth, TX 76102.*

R/C City, *215 Big Springs Ave., Tullahoma, TN 37388.*

Robart Mfg., *P.O. Box 1247, 625 N. 12th St., St. Charles, IL 60174; (708) 584-7616.*

Satellite City, *P.O. Box 836, Simi, CA 93062.*

Sheldon Engineering Co., *295 Jay St., Birchwood, MN 55110.*

Sig Mfg. Co., *401 S. Front St., Montezuma, IA 50171.*

Soarcraft, *N. 615 Farr Rd., Spokane, WA 99206.*

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SuperTigre; *distributed by Great Planes Model Distributors (see address above).*

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